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JANUARY 15, 1988

425A-5

DIGITAL CARRIER FAULT ANALYZER

OPERATION MANUAL

A025425A5B

This Addendum applies to test sets having S/N 806 and up, as well as earlier units which have had this feature added as an option.

ADDENDUM A
SOM 425A-5
Issues 1 and 2
July 15, 1988

ADDITIONAL TEST SIGNALS FOR ERROR DETECTION

INTRODUCTION

The Sierra Model 425A-5 provides three standard test signals:

QRW (standard quasi-random word)
QRW with errors
ALL ONES

This new feature adds two additional test signals to this group:

1:7 ("one" followed by seven "zeros")
1:15 ("one" followed by fifteen "zeros")

DESCRIPTION

On earlier production units the right-most key of the PCM Generator, labeled "ALL 1", selects a generator output of an All Ones signal. On test sets which incorporate this feature, this key is the "SIGNAL" key. When this key is pressed a new menu, shown in Figure 1, is presented.

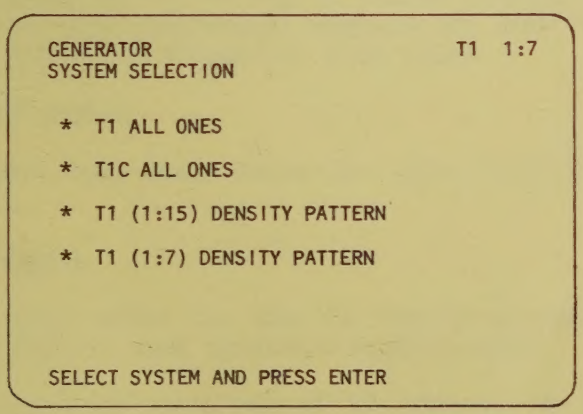

Fig. 1
Signal Selection Menu
Showing a 1:7 Signal Output

SELECTING A TEST SIGNAL

Use the procedure below to select a test signal on a 425A-5 which includes this new feature.

SIGNAL SELECTION INSTRUCTIONS

Step	Procedure
To select QRW:	
1	Press QRW.
2	Proceed with testing.
To select QRW with errors:	
1	Press ERRORS.
2	Proceed with testing.
To select another signal:	
1	Press SIGNAL (ALL 1 key on early production units).
2	Move the cursor with the UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice (See Figure 1).
3	Press ENTER to make a selection.
4	Proceed with testing.

MODIFICATION 1
ADDITIONAL TESTING CAPABILITY

INTRODUCTION

Modification 1 for the Sierra 425A-5 Digital Carrier Fault Analyzer is a standard feature for all instruments beginning with S/N 1041. All instruments which have been fitted or retrofitted with this modification have a label with the inscription "MOD 1" near the serial number nameplate on the rear panel.

It is also possible to determine whether the modification is installed by observing the initial display on the CRT screen: Unmodified instruments have software version numbers in the 2000 or 3000 range. Instruments with the new testing capability have version numbers from 4000 up.

> NOTE: Addendum A (dated July 15, 1988) for the 425A-5 Operation Manual applied to instruments having S/N 806 to S/N 1040. The software of these test sets included the 1:15 and 1:7 density patterns. Addendum A does not apply to instruments that have software version numbers 4000 and up.

DESCRIPTION OF THE MODIFICATION

The 425A-5 is designed to test all digital carrier systems in common use. The enhancements of this modification upgrade the instrument to add the following features which are frequently used today:

- 3 in 24 test signal;
- Loop-up and loop-down codes for both CSU and SMARTJACK application;
- 1:15 test signal;
- 1:7 test signal which can also be user-programmed over a wide range of ratios to meet operation requirements;
- an error-detection test time of 15 minutes, in addition to the standard range of test times previously available (from 3 seconds to 2 hours, and continuous);
- fault locate testing on a timed-interval basis, with interval selections from 15 minutes to 4 hours.

CHANGES TO THE OPERATION MANUAL

The information in Issues 1 and 2 of the 425A-5 Operation Manual is changed as follows (section and page numbers refer to manual):

- Section 2.6 - Instructions for Setting Default Values (pp 6-8);
- Section 2.8 - Fault Locate Test Instructions (pp 9-12);
- Section 2.11 - Error Detection Test Instructions (p 14);
- Section 2.12 - PCM Generator Output (pp 14-15);
- Section 3.2 - Front Panel Function Keys (pp 20-21);
- Section 4 - Technical Data - Transmitter (p 25);
- Section 4 - Technical Data - Error Detector (p 27);
- Section 4 - Technical Data - Default Menus (p 28).

For the convenience of the user, the three sets of stepped instructions in Section 2 are reproduced on the following pages with the changes shown in italics. A new set of stepped instructions is given when selecting the PCM Generator Output, and the changes in Sections 3 and 4 are explained. The new Default Menus are also included.

Changes to Section 2.6 (see pp 6-8 of manual):

INSTRUCTIONS FOR SETTING DEFAULT VALUES

Step	Procedure
1	Press DEFAULT MENU.
2	CRT displays page 1 of the Default Menu. Cursor appears in NO CHANGE position.
	NOTE: Page 1 now includes a selection entitled: Timed Fault Location Tests. This permits repetitive testing at selected intervals from 15 minutes to 4 hours.
3	Move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
4	Press ENTER to make selection.

(Instructions continued on next page.)

INSTRUCTIONS FOR SETTING DEFAULT VALUES (continued)

Step	Procedure
5	Repeat Steps 3 and 4 for each selection.
6	To display another page, press DEFAULT MENU.
7	CRT displays page 2 of the Default Menu. Cursor appears in the NO CHANGE position.
8	Repeat Steps 3 and 4 for each selection.
9	To display another page, press DEFAULT MENU.
10	CRT displays page 3 of the Default Menu. Cursor appears in the NO CHANGE position.
11	Page 3 displays six (6) fault line configurations. Cursor appears in the NO CHANGE position.
12	To change a configuration, move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
13	Move cursor into field of selected line with RIGHT arrow.
14	Move cursor to desired position with RIGHT and LEFT arrow keys.
15	Select lettered filters identifying the repeaters to be tested by pressing ENTRY keys A to M, as desired.
16	To define a powered fault line, press + or - before the list of lettered filters. The sign may be changed at any point in the list. The signs mean: (1) No sign indicates an unpowered fault line. (2) + indicates a line powered with a positive voltage. (3) - indicates a line powered with a negative voltage.
17	Press DISC to identify a discrete type repeater. (For T1 systems only.) When DISC is pressed: (1) The filter letter will be highlighted, to identify the discrete type repeater. (2) The cursor does not advance; therefore it is usual to press DISC before the lettered ENTRY key. (3) It has a toggle action: that is, first press identifies a discrete repeater; second press removes the indication.

(Instructions continued on next page.)

INSTRUCTIONS FOR SETTING DEFAULT VALUES (continued)

Step	Procedure
	NOTE: Usually repeaters are of the integrated type; that is, built with ICs. Discrete type repeaters are built with individual components. These two types need different compensation when the Fault Location Tests are made.
18	When the line configuration is satisfactory, position the cursor in the blank space immediately to the right of the selected information.
19	Press ENTER to indicate that the selected information is correct. The cursor will return to the position of the asterisk (*) in front of the line description.
20	*To display another page, press DEFAULT MENU.*
21	*CRT displays page 4 of the Default Menu. Cursor appears in the NO CHANGE position.*
22	*Page 4 displays two selections for Loop Commands:* *CSU provides a repetitive code of 10000 for Loop-Up, and of 100 for Loop-Down.* *SMARTJACK provides a repetitive code of 11000 for Loop-Up and 11100 for Loop-Down.*
23	*Move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.*
24	*Press ENTER to make selection.*
25	When all selections on all 4 pages are made as desired, position the cursor on SAVE CHANGES. This may be done on any page; all pages will be saved. If it is desired to return to the selections which were in memory when DEFAULT MENU was first pressed, position the cursor on NO CHANGE. This will discard all the changes which were entered.
26	Press ENTER to save or discard changes, depending on the placement of the cursor.

Changes to Section 2.8 (see pp 9-12 of manual):

FAULT LOCATE TEST INSTRUCTIONS

Step	Procedure
1	Press TRANS or OBSCR, as desired.
2	CRT displays the System Selection menu. The display shows the types of PCM systems which are enabled: T1, T1C, etc.
	NOTE: Systems are enabled by OPTION SWITCHES described in Section 5.7, page 32. If the desired PCM system is not displayed, make the necessary changes in switch S4. See Table 5-3, page 34.
3	Move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
4	Press ENTER to make selection.
5	CRT displays six (6) Fault Line Configurations. Initially these are taken from the Default Menu. Any line may be selected for the test, and the filter selection can be modified to suit. Modifications made on this menu do not affect the settings on the Default Menu.
6	Move cursor to desired line using UP and DOWN arrows.
7	If the filter configuration for the selected line is correct, GO TO 15.
8	If the filter configuration requires modification, move cursor into field of selected line with RIGHT arrow key.
9	Move cursor to desired position with RIGHT and LEFT arrow keys.
10	Select lettered filters identifying the repeaters to be tested by pressing ENTRY keys A to M, as desired.

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
11	To define a powered fault line, press + or - before the list of lettered filters. The sign may be changed at any point in the list. The signs mean: (1) No sign indicates an unpowered fault line. (2) + indicates a line powered with a positive voltage. (3) - indicates a line powered with a negative voltage.
12	Press DISC to identify a discrete type repeater. (For T1 systems only.) When DISC is pressed: (1) The filter letter will be highlighted, to identify the discrete type repeater. (2) The cursor does not advance; therefore it is usual to press DISC before the lettered ENTRY key. (3) It has a toggle action: that is, first press identifies a discrete repeater; second press removes the indication.
13	When the line configuration is satisfactory, position the cursor in the blank space immediately to the right of the selected information.
14	Press ENTER to indicate that the selected information is correct. The cursor will return to the position of the asterisk (*) in front of the line description.
15	Press ENTER to select the line which has been marked by the cursor.
16	At this point intermediate menus may be presented, depending on previous choices: (1) If a powered fault line has been chosen, and if voltage selection has been enabled (see Table 5-3, page 34), the Fault Line Voltage Selection menu is displayed, allowing a choice of voltages. GO TO 17. (2) If T1D has been selected, the Set Filter Type menu is displayed allowing selection of Active or Passive filters. GO TO 20. (3) If any other selections are made, the display shows the Signal Extraction Selection menu. GO TO 23.

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
17	CRT displays the Fault Line Voltage Selection menu if this function has been enabled (see Table 5-3, page 34). Choices of 45, 55, 100 or 110 volts are available.
18	Move the cursor to the desired voltage using the UP and DOWN arrow keys.
19	Press ENTER to select the item marked by the cursor.
20	CRT displays the Set Filter Type Menu if T1D was chosen (if not, GO TO 23). The display shows that Active or passive filters may be chosen.
21	Move the cursor to the desired filter type using the UP and DOWN arrow keys.
22	Press ENTER to select the item marked by the cursor.
23	CRT displays the Signal Extraction Menu. The display offers four choices: Quiet, Noisy, Very Noisy, and Automatic.
24	Move the cursor to the desired choice using the UP and DOWN arrows. The first 3 choices, Quiet, Noisy, and Very Noisy, select the number of tests which are performed. Since the results of the tests are combined and averaged, the more quiet the line, the sooner data can be presented. If Automatic is chosen, the 425A-5 selects the number of tests based on signal-to-noise measurements.
25	Press ENTER to select the item marked by the cursor.
26	*At this point an additional menu may be presented, depending on a previous choice which was made on the last item on Page 1 of the Default Menu, Timed Fault Locate Tests:* *(1) If YES has been selected, the Fault Locate Test Interval Selection menu is displayed.* *GO TO 27* *(2) If NO has been selected, the set-up is complete.* *GO TO 30*
27	*CRT displays the Fault Locate Test Interval Selection menu if Timed Fault Locate Tests have been chosen on*

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
	the Default Menu. Test intervals from 15 minutes to 4 hours may be selected. If only one test is desired, this choice is also available.
28	*Move the cursor to the desired time interval using the UP and DOWN arrow keys.*
29	*Press ENTER to select the item marked by the cursor.*
30	At this point the 425A-5 begins the test. The CRT displays the accumulated test data for each test when ready. Additional data displays are available using the DISPLAY keys. (See Section 2.9 of the Operation Manual.)

- -

Changes to Section 2.11 (see p 14 of manual):

ERROR DETECTION TEST INSTRUCTIONS

Step	Procedure
1	*Before beginning this test, select the PCM generator output that is desired for the measurements. (See the changed information for manual Section 2.12, below.)*
2	Connect an incoming PCM line to DETECTOR INPUT. (Be sure the incoming signal is as desired before starting the test. Do not change the signal or remove the plug during the test.)
3	Press ERROR DETECT.
4	*CRT displays the Expected Pattern Selection Menu. The display offers QRW, 3/24, 1:15 or OTHER. If OTHER is chosen, or if the selection does not match the PCM Generator output, only violations will by shown. If the selection matches the PCM Generator, both logic errors and violations will by displayed.*

(Instructions continued on next page.)

ERROR DETECTION TEST INSTRUCTIONS (continued)

Step	Procedure
5	*Move cursor by using the UP and DOWN arrow keys to select the desired signal pattern.*
6	*Press ENTER to select the signal pattern marked by the cursor.*
7	CRT displays the Test Time Selection Menu. The display shows various time selections. *Note that a test time of 15 minutes is available, in addition to the standard selections from 3 seconds to 2 hours, and continuous.*
8	Move cursor by using the UP and DOWN arrow keys to select the length of test desired.
9	Press ENTER to select the length of test marked by the cursor.
10	The 425A-5 begins the testing and the CRT displays the results cumulatively until the test is completed.
	If a 2-Hour or Continuous Test Time is chosen, there are two pages of displayed data. Page 2 shows the results in 5-minute increments for the 2-hour test, and in 1-hour increments for the continuous test. Press DET to see page 2, and press DET again to return to page 1.

Changes to Section 2.12 (see pp 14-15 of manual):

Three FUNCTION keys select the PCM generator output. The user has these choices:

QRW	Quasi-Random Word (QRW)
ERRORS	QRW with errors
SIGNAL	This choice (marked ALL 1 on early production units) brings up a series of selection menus. They are a new feature of MOD 1.

The selection of QRW or ERRORS is unchanged from the information in the manual. If SIGNAL is selected, follow the new procedure on the next page for signal selection.

SIGNAL SELECTION INSTRUCTIONS

Step	Procedure
1	Press SIGNAL (ALL 1 key on early production units.)
2	CRT displays the Generator System Selection menu. Available choices are T1 and T1C.
3	Move the cursor to the desired system using the UP and DOWN arrow keys.
4	Press ENTER to select the item marked by the cursor.
5	CRT displays the Generator Test Signal Selection menu. For each selection made, the generator will immediately begin transmitting the specified signal, and will continue to transmit the signal until another choice is made. The following selections are available: ALL ONES - Output set to all ones; CRT shows ALL 1. LOOP UP - Output set to the loop-up signal specified in the Default Menu; CRT shows LP UP. After 10 seconds, the CRT displays LOOP in inverse video. This display remains until the loop-down signal is selected. LOOP DOWN - Output set to the loop-down signal specified in the Default Menu; CRT shows LP DN. After 10 seconds the LOOP display is removed from the CRT. 3/24 - Output set to 3 in 24; CRT shows 3/24. 1:15 - Output set to 1:15; CRT shows 1:15. 10000000 - This is the user selectable position. The initial display is 1:7, as shown. When this selection is made, CRT shows USER.
6	Move the cursor by using the UP and DOWN arrows to select the desired signal pattern.
7	If the user selectable position is chosen, move the cursor into the pattern with the RIGHT and LEFT arrow keys. When the cursor is moved to the right into a blank space, a zero will appear. Up to 32 positions are available.
8	The UP arrow key is used to toggle the display at the cursor between 0 and 1. Only the display shown in

(Instructions continued on next page.)

SIGNAL SELECTION INSTRUCTIONS

Step	Procedure
	positions 2 through 9 may be toggled; position 1 is always a one; all other positions are always zero.
9	The DOWN arrow key is used to cut off the string of figures at the cursor when more are displayed than needed.
10	When the selection is complete, press ENTER to transmit the pattern marked by the cursor.
11	The test set returns to the display which was on the CRT before the PCM GENERATOR key was pressed.

Changes to Section 3.2 (see pp 20-21):

Figures 3-1 and 3-2 show the rightmost key of the PCM GENERATOR keys to be labeled ALL 1. On recent production units this key is labeled SIGNAL.

The description on page 21 of the manual should be changed to read:

PCM GENERATOR SIGNAL	Permits the selection of one of several transmitter signal outputs.

Changes to Section 4 (see pp 25-28):

On page 25, under the TRANSMITTER heading, add the following to the list of generator pulse patterns:

LOOP UP, LOOP DOWN, 3/24, 1:15, and USER (default at 1:7)

On page 27, under the ERROR DETECTOR heading, add the following to the list of measurements:

Logic errors (w/QRW, 3/24, or 1:15)

On page 28, under the DEFAULT MENUS heading, replace the three (3) video pages with the four (4) shown below. Square brackets [ ] indicate the choices selected when the instrument is first shipped from the factory.

```
DEFAULT DISPLAY PAGE 1              T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  FORM FEED BEFORE PRINT          YES
 *                                 [NO]
 *  CLEAR CHANNEL                  [NO]
 *                                  YES
 *  MEASURE 2 AND 3 LIMITS         [5 TO 7 DB]
 *                                  4 TO 8 DB
 *  IDLE MODE PCM                  [QRW]
 *                                  MEASURE 1
 *  ERROR TYPE                     [VIOLATIONS]
 *                                  LOGIC
 *  TIMED FAULT LOC TESTS          [NO]
                                    YES
PRESS DEFAULT FOR PAGE 2
```

```
DEFAULT DISPLAY PAGE 2              T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  OBSCURE TEST ANALYSIS          [REFERENCE]
 *                                  RELATIVE
 *  OBSCURE LOWER LIMIT            [-0.5 DB]
 *                                  -1.0 DB
 *                                  -1.5 DB
 *  OBSCURE UPPER LIMIT            [+1.0 DB]
 *                                  +1.5 DB
 *  MAXIMUM STRESS                 [DENSITY 4]
 *                                  DENSITY 5

         OFFICE LOCATION/MACHINE ID

PRESS DEFAULT FOR PAGE 3
```

```
DEFAULT DISPLAY PAGE 3              T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  LINE 1:  [ABCDEFGHJKLM]

 *  LINE 2:  [+ABCDEFGHJKLM-MLKJHGFEDCBA]

 *  LINE 3:  [C]

 *  LINE 4:  [D]

 *  LINE 5:  [E]

 *  LINE 6:  [F]

PRESS DEFAULT FOR PAGE 4
```

```
DEFAULT DISPLAY PAGE 4              T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  LOOP COMMANDS                  [CSU]
 *                                  SMARTJACK




PRESS DEFAULT FOR PAGE 1
```

425A-5

DIGITAL CARRIER FAULT ANALYZER TEST SET

OPERATION MANUAL

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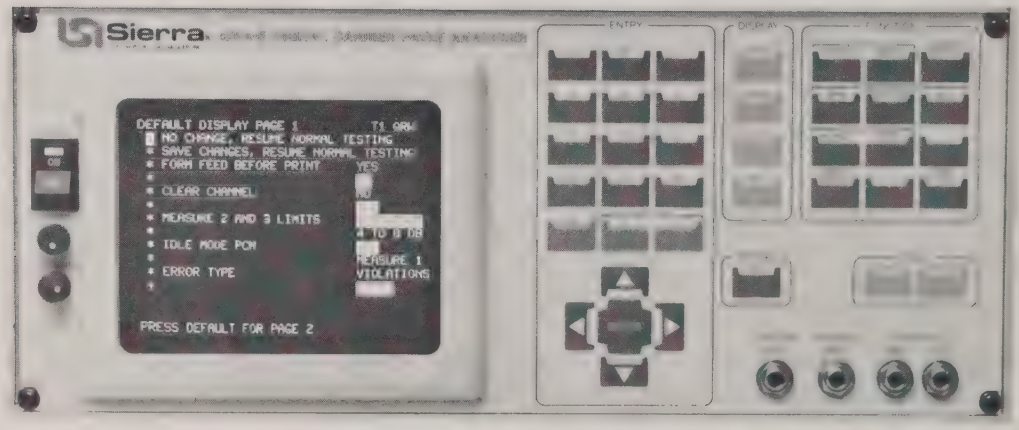

Fig. 1-1
425A-5 Showing Page 1 of the Default Menu

1. GENERAL INFORMATION

INTRODUCTION

1.1 The Sierra 425A-5 Digital Carrier Fault Analyzer (DCFA) is a microprocessor-controlled instrument, designed to test all digital carrier systems in common use today. The 425A-5 DCFA is a dual-function unit designed for use during installation and maintenance. The instrument is furnished in a portable case with a handle which serves as a support when in use. The 425A-5 DCFA can also be arranged for 19-in rack mounting.

CONNECTIONS AND APPLICATIONS

1.2 The 425A-5 DCFA can be operated from the front panel to perform all tests locally. In addition, it can be operated remotely from a console terminal at any selected location. Provision is also included for the operation of an auxillary hard copy printer to display the data developed by the 425A-5.

Connections to the test circuits are made at 310 jacks on the front panel of the instrument. Connections to the remote console terminal use an RS-232C interface connector on the rear panel. Connections to the auxiliary printer are made at the rear panel, using an RS-232C interface connector.

The power connections for 115 or 230 VAC, 50 or 60 Hz, are also made on the rear panel.

FUNCTIONAL DESCRIPTION

1.3 The 425A-5 DCFA provides the two principal functions needed for central-office testing:

(a) error detection, counting, and analysis

(b) span line fault-locating

The error detector works with either a T1 or T1C signal and is designed specifically for use at a DSX bay. It accomodates T1 systems with standard AMI coding, as well as "clear channel" with B8ZS coding.

Fault-locating is provided for T1, T1C, T1D, T148C, and 9148A systems. The first three systems can be interfaced at either a DSX or Office Repeater Bay; the latter two have a special jack on the Office Repeater for fault-locating.

The 425A-5 DCFA is compatible in all respects with existing fault-locating systems. It may be used with passive filters or filter-amplifiers and the standard fault-locating pair is utilized in the conventional manner. Standard test patterns are used; however, the entire test is executed automatically.

Test results are analyzed by a microcomputer, in conformance with accepted industry practice, and the data are formatted in a visual presentation so as to eliminate the need for a "paper analysis".

Hard copy may be provided using an external printer. The set may also be controlled remotely.

DIGITAL TRANSMISSION SYSTEMS AND THEIR MAINTENANCE

1.4 In Appendix A of this Operation Manual the user will find a general description of digital transmission systems and the maintenance techniques associated with such systems. This material is provided to aid in comprehending T-Carrier systems in use today, together with established methods of finding operating troubles.

2. OPERATION

RECEIVING INFORMATION

2.1 When the test set is received, unpack and inspect it carefully. Retain the shipping carton and packing material to return unit for maintenance or calibration. Check the equipment received against the order.

CUSTOMER SERVICE

2.2 If the test set is found to be damaged or does not operate properly, or if the contents of the shipment are not complete, contact Sierra Customer Service Department. See Section 5.2, page 29.

POWER REQUIREMENTS

2.3 When shipped from the factory, the 425A-5 is connected for 115 VAC operation at either 50 or 60 Hz. If it is desired to operate at 230 VAC, Section 5.5, page 29, gives instructions for opening the set and making the necessary changes in internal wiring.

APPLYING POWER

2.4 When the power is turned ON, there is a brief initialization period before the set is ready to be used for testing. When ready, the screen displays an introduction showing the version of the software, and it includes instructions on how to proceed with testing.

The initialization at power-up does not include a self-test of the condition of the set. If the user desires to be assured that the test set is operating correctly, a self test can be performed on the various circuits and functions of the instrument by pressing SELF TEST when no plugs are connected to the front panel.

- If the set passes the self-test, the CRT screen indicates this fact and then the introductory display is again presented.

- If an error message appears during the self-test sequence, the test set will not continue to the introductory display.

For more information on Self Test, see Section 5.6, page 29.

OPERATING PARAMETERS

2.5 When the POWER switch is turned ON, or when the Self Test function is used, the test set is ready to function using operating parameters that have been determined in one of two ways:

(1) from values stored in permanent memory on the Default Menu. These are always available and may be used without change if they meet the requirements of the test being done.

(2) from values selected when a particular test is initiated. When a FUNCTION key is pressed to select a particular test, the user may first choose the operating parameters for the test. For this, menus are presented during the set-up procedure before the test is begun. The selections made at this time apply until changed on a subsequent test, or until SELF TEST is pressed, or until another power-up.

DEFAULT MENU

2.6 Operating parameters for the 425A-5 are stored in permanent memory. These parameters can be displayed, and changed if desired, by pressing the key labeled DEFAULT MENU. When an item on the Default Menu is changed, the new parameter becomes the default value as soon as SAVE CHANGES is executed. The former value is lost.

The CRT displays three video pages for the Default Menu. These pages are illustrated in Section 4, Technical Data. To display or change the default values, proceed as follows:

INSTRUCTIONS FOR SETTING DEFAULT VALUES

Step	Procedure
1	Press DEFAULT MENU.
2	CRT displays page 1 of the Default Menu. Cursor appears in NO CHANGE position.
3	Move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
4	Press ENTER to make selection.
5	Repeat steps 3 and 4 for each selection.
6	To display another page, press DEFAULT MENU.

(Instructions continued on next page.)

INSTRUCTIONS FOR SETTING DEFAULT VALUES (continued)

Step	Procedure
7	CRT displays page 2 of the Default Menu. Cursor appears in the NO CHANGE position.
8	Repeat Steps 3 and 4 for each selection.
9	To display another page, press DEFAULT MENU.
10	CRT displays page 3 of the Default Menu. Cursor appears in the NO CHANGE position.
11	Page 3 displays six (6) fault line configurations. Cursor appears in the NO CHANGE position.
12	To change a configuration, move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
13	Move cursor into field of selected line with RIGHT arrow.
14	Move cursor to desired position with RIGHT and LEFT arrow keys.
15	Select lettered filters identifying the repeaters to be tested by pressing ENTRY keys A to M, as desired.
16	To define a powered fault line, press + or - before the list of lettered filters. The sign may be changed at any point in the list. The signs mean: (1) No sign indicates an unpowered fault line. (2) + indicates a line powered with a positive voltage. (3) - indicates a line powered with a negative voltage.
17	Press DISC to identify a discrete type repeater. (For T1 systems only.) When DISC is pressed: (1) The filter letter will be highlighted, to identify the discrete type repeater. (2) The cursor does not advance; therefore it is usual to press DISC before the lettered ENTRY key. (3) It has a toggle action: that is, first press identifies a discrete repeater; second press removes the indication.

NOTE: Usually repeaters are of the integrated type; that is, built with ICs. Discrete type repeaters are built with individual components. These two types need different compensation when the Fault Location Tests are made.

(Instructions continued on next page.)

INSTRUCTIONS FOR SETTING DEFAULT VALUES (continued)

Step	Procedure
18	When the line configuration is satisfactory, position the cursor in the blank space immediately to the right of the selected information.
19	Press ENTER to indicate that the selected information is correct. The cursor will return to the position of the asterisk (*) in front of the line description.
20	When all selections on all 3 pages are made as desired, position the cursor on SAVE CHANGES. This may be done on any page; all pages will be saved. If it is desired to return to the selections which were in memory when DEFAULT MENU was first pressed, position the cursor on NO CHANGE. This will discard all the changes which were entered.
21	Press ENTER to save or discard changes, depending on the placement of the cursor.

TESTS PERFORMED

2.7 The FAULT LINE TEST checks whether there is any fault line voltage (which means the fault line is in use), and measures resistance and C-message noise, in order to establish the integrity of the fault line. All three fault line tests are performed automatically before either the Transmission or Obscure Fault Location test is started. The Fault Line Resistance and Fault Line Noise tests can be made independently from the front panel of the test set.

The FAULT LOCATION TEST operates automatically in two modes: the Transmission Fault Location test and the Obscure Fault Location test. The fault location tests provide data allowing identification of faulty repeaters in a digital carrier system.

The ERROR DETECTION TEST provides both an indication of errors and a BERT (Bit Error Rate Test) error analysis calculation for errors on the digital carrier signal. The 425A-5 provides for error detection on T1 and T1C signals only. The test may be performed for fixed time periods or continuously.

In addition, the 425A-5 contains an internal PCM generator which will supply a standard Quasi-Random Word (QRW), a QRW with errors, and All Ones. These outputs are controlled from the front panel of the test set.

FAULT LOCATION TESTING

2.8 The 425A-5 performs an automatic fault-locate test on a span line, and the results are presented in several charts which can be displayed on the CRT screen or printed out on an auxiliary printer. Fault line noise and resistance are included in the results.

To begin the automatic Fault-Locate Test, make these connections at the DSX or ORB: the Fault Line to the 425A-5 FAULT LINE INPUT jack, and the LINE IN to the 425A-5 GENERATOR OUT jack. Then press one of the FAULT LOC push buttons: TRANS or OBSCR. Both begin the test, but each provides a different emphasis. The 425A-5 will abort the test unless the sleeve of the input jack is grounded.

TRANS performs the Transmission Fault Locate Test, which tests M1, M2 and M3 at density 11 only. If a bad repeater can be identified with this information, no further tests are performed. If a bad repeater cannot be identified with this test, the 425A-5 then performs the Obscure Fault Locate Test, which tests M1, M2 and M3 at density 11 and also M1 at densities 10 to 4 (or densities 10 to 5 if the default is set for this). The test program automatically displays the results of the Transmission Fault Locate Test on the CRT.

OBSCR performs the full Obscure Fault Locate Test without stopping after the density 11 test. The test program automatically displays the results of the Obscure Fault Locate Test first; with the data from the Transmission Fault Locate Test available by pressing the DISPLAY pushbutton labeled TRANS (FAULT on early models).

Since the Transmission Fault Locate Test runs about three times as fast as the Obscure Fault Locate Test, considerable time is saved if the problem can be identified with the first test only. Follow the procedure below to perform the automatic Fault Locate Test:

FAULT LOCATE TEST INSTRUCTIONS

Step	Procedure
1	Press TRANS or OBSCR, as desired.
2	CRT displays the System Selection menu. The display shows the types of PCM systems which are enabled: T1, T1C, etc.
	NOTE: Systems are enabled by OPTION SWITCHES described in Section 5.7, page 32. If the desired PCM system is not displayed, make the necessary changes in switch S4. See Table 5-3, page 34.

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
3	Move cursor with UP or DOWN arrow keys to position it on the asterisk (*) in front of the desired choice.
4	Press ENTER to make selection.
5	CRT displays six (6) Fault Line Configurations. Initially these are taken from the Default Menu. Any line may be selected for the test, and the filter selection can be modified to suit. Modifications made on this menu do not affect the settings on the Default Menu.
6	Move cursor to desired line using UP and DOWN arrows.
7	If the filter configuration for the selected line is correct, GO TO 15.
8	If the filter configuration requires modification, move cursor into field of selected line with RIGHT arrow key.
9	Move cursor to desired position with RIGHT and LEFT arrow keys.
10	Select lettered filters identifying the repeaters to be tested by pressing ENTRY keys A to M, as desired.
11	To define a powered fault line, press + or - before the list of lettered filters. The sign may be changed at any point in the list. The signs mean: (1) No sign indicates an unpowered fault line. (2) + indicates a line powered with a positive voltage. (3) - indicates a line powered with a negative voltage.
12	Press DISC to identify a discrete type repeater. (For T1 systems only.) When DISC is pressed: (1) The filter letter will be highlighted, to identify the discrete type repeater. (2) The cursor does not advance; therefore it is usual to press DISC before the lettered ENTRY key. (3) It has a toggle action: that is, first press identifies a discrete repeater; second press removes the indication.

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
13	When the line configuration is satisfactory, position the cursor in the blank space immediately to the right of the selected information.
14	Press ENTER to indicate that the selected information is correct. The cursor will return to the position of the asterisk (*) in front of the line description.
15	Press ENTER to select the line which has been marked by the cursor.
16	At this point intermediate menus may be presented, depending on previous choices: (1) If a powered fault line has been chosen, and if voltage selection has been enabled (see Table 5-3, page 34), the Fault Line Voltage Selection menu is displayed, allowing a choice of voltages. GO TO 17. (2) If T1D has been selected, the Set Filter Type menu is displayed allowing selection of Active or Passive filters. GO TO 20. (3) If any other selections are made, the display shows the Signal Extraction Selection menu, the final menu. GO TO 23.
17	CRT displays the Fault Line Voltage Selection menu if this function has been enabled (see Table 5-3, page 34). Choices of 45, 55, 100 or 110 volts are available.
18	Move the cursor to the desired voltage using the UP and DOWN arrows.
19	Press ENTER to select the item marked by the cursor.
20	CRT displays the Set Filter Type Menu if T1D was chosen (if not, GO TO 23). The display shows that Active or passive filters may be chosen.
21	Move the cursor to the desired type using the UP and DOWN arrows.
22	Press ENTER to select the item marked by the cursor.

(Instructions continued on next page.)

FAULT LOCATE TEST INSTRUCTIONS (continued)

Step	Procedure
23	CRT displays the Signal Extraction Menu. The display offers four choices: Quiet, Noisy, Very Noisy, and Automatic.
24	Move the cursor to the desired choice using the UP and DOWN arrows. The first 3 choices, Quiet, Noisy, and Very Noisy, select the number of tests which are performed. Since the results of the tests are combined and averaged, the more quiet the line, the sooner data can be presented. If Automatic is chosen, the 425A-5 selects the number of tests based on signal-to-noise measurements.
25	Press ENTER to select the item marked by the cursor.
26	At this point the 425A-5 begins the test. The CRT displays the accumulated test data for each test when ready. Additional data displays are available using the DISPLAY keys. (See 2.9, below.)

DATA DISPLAYS

2.9 Four display keys are available to display various parts of the test results. If the test is in progress, the results are presented as soon as the test is completed. Otherwise the information is taken from the last test performed.

TRANS gives the results of the Transmission Fault Locate Test.

TREND gives the repeater performance for each filter. Press the DOWN arrow for the first display. Then press the DOWN arrow to step forward through the filters; the UP arrow to reverse.

OBSCR gives the results of the Obscure Fault Locate Test.

DET gives the results of the Error Detection Test.

In the UPPER RIGHT CORNER of each screen, the output of the signal generator is displayed. This signal source is used by the Fault Locate Test program, but not by the Error Detection Test program.

The second line of the Transmission Fault Locate Display shows two characteristics of the fault line: Noise (dBrn) and Resistance (Ohms). These are taken at the beginning of the test.

If an item on the CRT screen is blinking, the measured value is out of tolerance. If an item is missing, the test circuit may be open.

FAULT LINE TESTING

2.10 Fault Line testing is performed as part of Fault Location testing. Fault Line Noise and Fault Line Resistance can also be performed as individual tests. The controls for these two tests have a toggle action; that is, press NOISE to start the noise test, and press NOISE again to end the test. The results of the test are presented continuously while the test is in progress. When the test is ended, the display no longer shows the results of the test.

ERROR DETECTION TESTING

2.11 The 425A-5 provides an indication of errors and performs an error analysis calculation on a Bit Error Rate Test (BERT) for T1 and T1C signals. The following functions are provided:

1. Detect the identify proper signals.
2. Detect and count violations.
3. Synchronize to QRW and count logic errors.
4. Detect All Ones pattern
5. Count burst seconds
6. Detect an oscillating line (T1 only)
7. Calculate error seconds
8. Calculate error rate
9. Display periodic error counts
10. Display periodic burst seconds

The Error Detection Test uses the signal supplied at the detector input.

The signal which is used can be externally supplied, or it can be looped back from the PCM signal generator in the 425A-5. If the internal signal is looped back, the user must select the generator output before performing the test. See the instructions in Section 2.12, page 14.

See the next page for test instructions. At the start of the test:

1. If no signal is detected, the test is aborted.
2. If a QRW is detected, error rate and error seconds are based on logic errors.
3. For any other signal, error rate and error seconds are based on bipolar violations.

If the incoming signal is interrupted or changed at any time during the selected test period, the collected data will not be accurate. However, the test will be continued until a new command is given.

After the start of the test, if the 425A-5 detects that the incoming signal has changed or disappeared, the words LOSS OF SIGNAL show on the third line of the display.

ERROR DETECTION TEST INSTRUCTIONS

Step	Procedure
1	Connect an incoming PCM line to DETECTOR INPUT. (Be sure the incoming signal is as desired before starting the test. Do not change the signal or remove the plug during the test.)
2	Press ERROR DETECT.
3	CRT displays the Test Time Selection Menu. The display shows various time selections.
4	Move cursor by using the UP and DOWN arrows to select the length of test desired.
5	Press ENTER to select the length of test marked by the cursor.
6	The 425A-5 begins the testing and the CRT displays the results cumulatively until the test is completed. If a 2-Hour or Continuous Test Time is chosen, there are two pages of displayed data. Page 2 shows the results in 5-minute increments for the 2-hour test, and in 1-hour increments for the continuous test. Press DET to see page 2, and press DET again to return to page 1.

PCM GENERATOR OUTPUT

2.12 Three FUNCTION keys select the PCM generator output. The user has these choices:

QRW	Quasi-Random Word (QRW)
ERRORS	QRW with Errors
ALL 1	All Ones

When one of these selections is made, the display offers a choice of systems:

T1 and T1C are always available.

T1 CC (T1 with B8ZS coding, called "Clear Channel") is also available if CLEAR CHANNEL has been enabled with a YES on the Default Menu.

If QRW or ALL 1 is selected, the generator is set to the selected output when the choice of system is made.

If ERRORS is selected, the user then must select the error rate. For this the ERROR RATE SELECTION Menu is displayed. The menu includes instructions to set the error rate, which may be anywhere from 9×10^{-2} to 1×10^{-9}.

When the error rate has been chosen, the generator is set to the selected output.

> NOTE: The user must take care not to change the generator output while a test is in progress. This selection must be made before the test is started.

MULTIPLE TESTING

2.13 The Fault Locate Test and the Error Detection Test operate independently of each other. If an external signal is used for the Error Detection Test, Tests may be made using both parts of the test set simultaneously. For example, begin a 2-hour Error Detection Test. While this test is in progress, connect a fault line and proceed with testing as desired. Move from one display to another at will, using the DISPLAY keys.

REPEAT TEST KEY

2.14 A REPEAT TEST key is provided on the front panel. If the user desires to repeat a test which has been completed, press this key. The test will be repeated using the parameters that were previously selected. If multiple testing is in progress, press the function key for the desired test, before pressing the REPEAT TEST key.

USING A PRINTER

2.15 The 425A-5 may be used with an external printer. The printer must be the serial type which operates from the RS-232C interface. There is no provision for making connections to a parallel printer.

The rear panel of the 425A-5 is equipped with two RS-232C interface ports, marked MODEM and PRINTER. These ports provide the following connections:

The MODEM port provides a standard RS-232C interface.

The PRINTER port includes a built-in null modem.

A near-by switch selects which port is operable. There is no provision for simultaneous use of the two ports.

Selecting a Printer. Any 80-column, serial printer with baud rates from 50 to 19200 can be operated by the 425A-5, provided the printer is able to keep up, or has adequate buffer storage. If the buffers are limited so that their storage may be filled, the printer must have XON/XOFF capability.

A simple printer, adequate for all ordinary printing, is available as an accessory to the 425A-5. See Sierra Part No. A03631300 in the list of Parts and Accessories, Section 5.8, page 35.

Setting Interface Parameters. After determining the characteristics of the printer, the interface output of the 425A-5 must be set to match. If the A03631300 printer is used, the settings of the Option Switches and Default Values are correct when the 425A-5 is shipped from the factory.

Whether to have a form-feed before printing is selected on Page 1 of the Default Menu.

Baud rate, data format, and communications protocol are selected by internal dip-switches. To set these, see OPTION SWITCHES, Section 5.7, page 32.

Operating the Printer. Two PRINT controls are available on the front panel of the 425A-5:

(1) Press SCREEN to print a copy of the information displayed on the CRT of the test set.

(2) Press RECORD to print a complete record of the last Fault Locate test that was performed.

When printing, the 425A-5 supplies a standard header for each page of the output. This header includes a space to fill in the following information:

Date
Name
Office
Span
Slot
Side
Case

These spaces are ordinarily left blank by the printer, but the Office Location can be printed automatically. This selection can be made from a remote terminal as part of the task of changing the the Default Menu. Here, up to 40 characters may be used. This selection cannot be made using the controls on the front panel of the 425A-5.

REMOTE OPERATION

2.16 The 425A-5 is capable of full remote operation. When in this mode, all instructions for operating the system, including all test procedures, are supplied electronically at the remote position; no additional information is needed. Therefore this Operation Manual provides only the necessary information to set up a remote station.

Selecting a Console. First the user must select an appropriate remote console with a keyboard and a CRT display unit. The software programs of the 425A-5 are designed for a 24 x 80 video display terminal or teleprinter. On a video terminal, old information is scrolled off the top of the screen using line feeds.

The terminal selected must have the capability of both upper and lower case character display. While there are many available terminals which can be used as the remote console, a simple unit like the LSI ADM-3A+ or the LSI ADM-3E is completely satisfactory for this application. The ADM terminals are available from LSI Data Products Division.

Circuit Connections. The remote terminal equipment is connected to the 425A-5 using one of the RS-232C interface connectors of the test set. If the Remote Console and the 425A-5 are nearby, the interconnection can be made using an RS-232C interface cable connected to the PRINTER port, which includes a NULL modem. If the Remote Console is to be connected to the test set by telephone lines, connections are made using modems. In this case, the MODEM port of the 425A-5 is used.

Switch Settings. Before operating the system over the remote link, the baud rate and protocol must be set to compatible choices at each end. Section 5 of this manual gives factory settings and instructions to set the option switches which are available on the 425A-5. Most consoles have matching switches to permit the selection of the best conditions for the particular system. The remote terminal must be set for full duplex operation, and the automatic line feed must not be enabled.

Using the Remote Console. When the system is set up, the Remote Console is ready for use. To begin remote operation, press the Space Bar. This will initiate the first menu on the console display, which requires the user to give an affirmative response before entering the remote mode. When this is given, the 425A-5 proceeds to transfer control from the local keyboard to the remote terminal. The 425A-5 then displays:

KEYBOARD DISABLED
BY REMOTE OPERATOR

At this point, the remote station is in control of the operation of the 425A-5. All instructions for using the test set are displayed at the remote location.

Problems During Remote Operation. Occasionally, the user may find communication cut off between the remote console and the 425A-5. This sometimes happens when a control character is pressed inadvertently. If the 425A-5 Communications Protocol Options are set for XON/XOFF, the console is capable of interrupting the data stream from the test set:

Press CTRL and S to stop data output from the test set.

Press CTRL and Q to resume data output from the test set.

If this feature is a problem for the user, the 425A-5 Communications Protocol Options should be set for No Response when the 425A-5 is being used with a remote console. See Option Switches, Section 5.7, page 32, and Table 5-3, page 34.

Restoring Local Control. When the user has finished with the remote console and wishes to return to local operation, this choice can be made from the Main Menu. Also, if the 425A-5 POWER switch is turned OFF and then ON, the test set will return to local control.

3. PHYSICAL DESCRIPTION

GENERAL APPEARANCE

3.1 The Sierra 425A-5 is a portable instrument housed in a sturdy metal case with a full-width handle. The front panel has a CRT to display data and test results. The operating controls and the connectors for the test circuit are also located on the front panel. The power input and the interface connectors for other pieces of equipment are located on the rear panel.

The test set has a number of options which are controlled by switches which are located internally on one of the printed wiring boards. These are accessed by removing a cover plate on the rear panel.

See Section 4, Technical Data, for weights and dimensions.

Optional accessories are listed in Section 5.8, page 35.

CONTROLS, CONNECTORS AND CRT DISPLAY

3.2 Front and rear panel features are described in the following tables and figures:

Front Panel Controls, Connectors, and CRT:

Table 3-1 Fig. 3-1 Page 20

Front Panel FUNCTION Keys:

Table 3-2 Fig. 3-2 Page 21

Front Panel ENTRY Keys:

Table 3-3 Fig. 3-3 Page 22

Front Panel DISPLAY, REPEAT, and PRINT Keys:

Table 3-4 Fig. 3-4 Page 23

Rear Panel Features:

Table 3-5 Fig. 3-5 Page 24

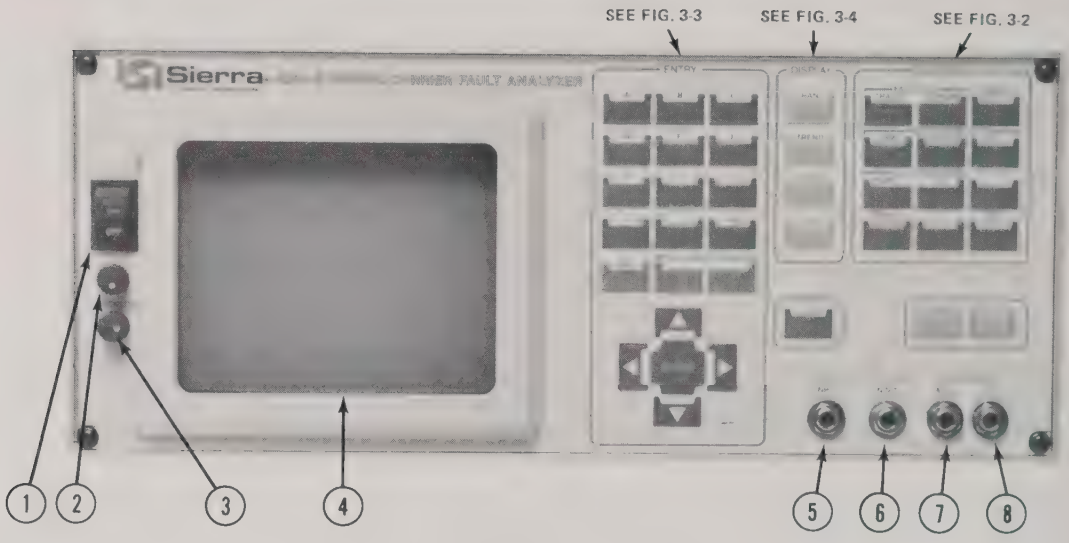

Fig. 3-1
425A-5 Front Panel

TABLE 3-1
FRONT PANEL CONTROLS, CONNECTORS, AND CRT

Index Number	Name	Description
1	POWER switch and indicator	Rocker switch with ON and OFF positions; green indicator illuminated when ON.
2	VOLUME control	Adjusts volume of loudspeaker.
3	INTENSITY control	Adjusts brightness of CRT display.
4	CRT	Cathode Ray Tube displays data.
5	DETECTOR INPUT jack	Accepts input from Monitor or Out jack on DSX or ORB; provides standard PCM termination during Error Detection Test.
6	FAULT LINE INPUT jack	Connects to Fault-Locate pair; provides 900-Ohm termination.
7	GENERATOR MON jack	Provides bipolar signal at monitor-jack level (has 430 Ohms in each lead).
8	GENERATOR OUT jack	Provides bipolar signal at ±3 V base-to-peak at standard PCM impedance level.

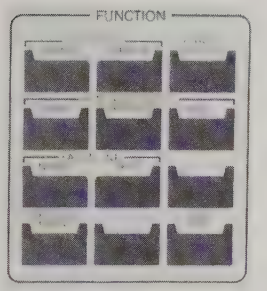

Fig. 3-2
FUNCTION Keys

TABLE 3-2
FRONT PANEL FUNCTION Keys

Name	Description
FUNCTION keys select test functions to be performed by the instrument.	
FAULT LOC TRANS	Selects the Fault Locate Test Function; first performs the Transmission Fault Locate Test; and, if no bad repeater is found, performs the Obscure Fault Locate Test.
FAULT LOC OBSCR	Selects the Fault Locate Test Function; performs both the Transmission Fault Locate Test and the Obscure Fault Locate Test sequentially.
ERROR DETECT	Selects the Error Detection Test Function.
PCM GENERATOR QRW	Sets the output of the PCM Generator to a standard Quasi-Random Word (QRW).
PCM GENERATOR ERRORS	Sets the output of the PCM Generator to a QRW with errors.
PCM GENERATOR ALL 1	Sets the output of the PCM Generator to All Ones.
FAULT LINE NOISE	Performs a noise test on the Fault Line.
FAULT LINE RES	Measures the resistance of the Fault Line.
DEFAULT MENU	Permits review or change of the Defaults.
SELF TEST	Tests the performance of the test set.

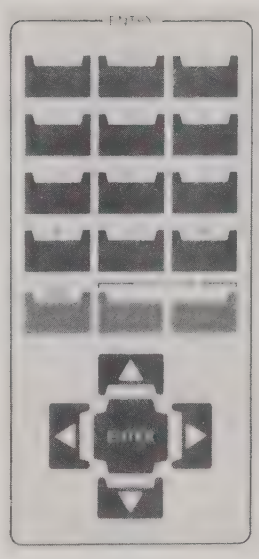

Fig. 3-3
ENTRY Keys

TABLE 3-3
FRONT PANEL ENTRY Keys

Name	Description
ENTRY keys select filters, move the cursor, and enter program data.	
Letter keys (A through M)	Selects filter types for the Fault Line configuration.
DISC key	(For T1 systems only.) If pressed before a filter key (A-M), changes compensation for the repeater. The initial selection (default) is for Integrated repeaters (built with ICs). When changed, compensates for the Discrete type (built with individual components).
+, - keys	These signs are entered at the beginning of the fault line configuration: No sign indicates an unpowered fault line. + means powered with a positive voltage. - means powered with a negative voltage.
Arrow keys	Moves the cursor in the direction indicated. Also used to move through certain sequential displays, such as TREND.
ENTER key	Terminates an entry, indicating that the cursor is on desired item. After entering all data, this key then starts the test.

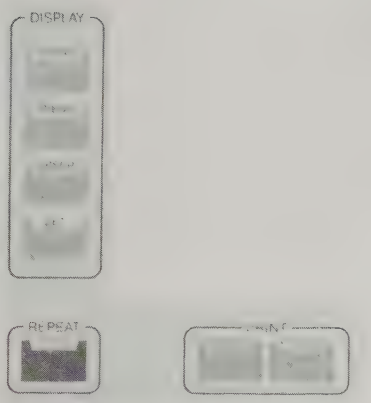

Fig. 3-4
DISPLAY, PRINT,
and REPEAT keys

TABLE 3-4
FRONT PANEL DISPLAY and CONTROL Keys

Name	Description

DISPLAY keys select the display seen on the Cathode Ray Tube (CRT). If the display is that of an executing test function, it is updated at a rate of 10 times/sec. If the test function is not active, the most recent display data for the function is used.

TRANS *	Selects the transmission display.
OBSCR	Selects the obscure trouble display.
TREND	Selects repeater trend display.
DET	Selects the error detection display.

Control keys consist of REPEAT and PRINT keys. These control the operation of the test set. If no printer is connected, the PRINT task is aborted in approximately 5 seconds.

REPEAT TEST	Causes the last function which was executed to be executed again.
PRINT SCREEN	Prints a copy of the CRT screen on the device connected to the RS-232C PRINTER port.
PRINT RECORD	Prints a complete record of the last fault line test that was performed.

*NOTE: On early models, this key is labeled FAULT.

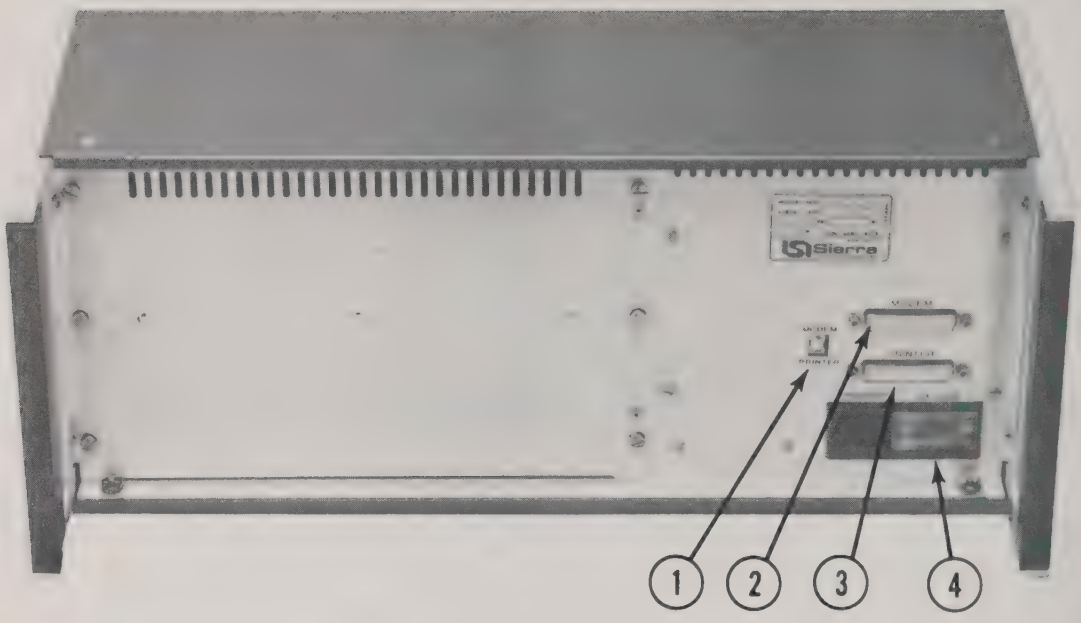

Fig. 3-5
425A-5 Rear Panel

TABLE 3-5
REAR PANEL FEATURES

Index Number	Name	Description
1	MODEM-PRINTER switch	Selects RS-232C output for connection to external equipment.
2	MODEM connector	RS-232C interface connector for use of external or remote controller.
3	PRINTER connector	RS-232C interface connector for use with an external printer.
4	POWER connector and 2A FUSE	Connection point for input power, and location of power fuse. Fuse can only be removed when power cord is removed from instrument, by sliding plastic cover over power connector.

4. TECHNICAL DATA

TRANSMITTER

Generator

Output signal	DS or MONITOR level
Bit rate	T1: 1.544 Mb/s T1C: 3.152 Mb/s
Pulse pattern	QRW: (2^{20} -1) T1 limited to 14 zeros or T1 (clear channel) QRW w/ERRORS: same but with BPV or logic errors at a selectable rate of 1 x 10^{-9} min to 9 x 10^{-2} max ALL ONES
Output jack impedance	105 ±10% Ohms
Monitor jack	430-Ohm series resistors in both lines (tip and ring) 1000 Ohms when terminated with a test set having a nominal 100-Ohm impedance (-20 dB)

Fault Locate Signals

Bit rate	T1: 1.544 Mb/s T1 with B8ZS coding (clear channel) T1C: 3.152 Mb/s T1D: 3.152 Mb/s with +5 VDC simplex T148C: 2.364 Mb/s 9148A: 3.152 Mb/s
Pulse amplitude	3 ±10% volts base-to-peak
Pulse afterkick	Nominally 20%, T1 only
Pulse patterns	M1: alternating (+) and (-) trios M2: (+) trios with BP pair M3: (-) trios with BP pair
(T1D) (selectable)	64 bit word with "A" and "B" bytes (select ACTIVE filters), or with "A" and enhanced "B" bytes (select PASSIVE filters).
Stress density (selectable)	11 - one trio in 11 slots increasing to 4 - one trio in 4 slots (or 5, if so programmed)
(T1D)	3 "B" bytes increasing to 8 per word

TECHNICAL DATA (continued)

Fault locate frequencies	A 832 Hz	G 1722 Hz
	B 928 Hz	H 2008 Hz
	C 1048 Hz	J 2193 Hz
	D 1206 Hz	K 2413 Hz
	E 1340 Hz	L 2680 Hz
	F 1508 Hz	M 3017 Hz
Frequency accuracy	2%	

FAULT LOCATE RECEIVER

Frequency range	800 to 3100 Hz (nominal)
Input level	-99 to 0 dBm
Level accuracy	±1 dB
Detector	Correlator controlled by transmitter
Effective bandwidth	Varies from 0.03 Hz to 3 Hz
Obscure Test Limits:	
Analysis Type (selectable)	REFERENCE: with respect to reference density RELATIVE: with respect to preceding density
Lower Limit (selectable)	-0.5 dB, -1.0 dB, or -1.5 dB
Upper Limit (selectable)	+1.0 dB, or +1.5 dB
Balance signal limits:	
M2 and M3 with respect to M1 (selectable)	-6 dB ±1 dB, or -6 dB ±2 dB
M2 with respect to M3	±1 dB
Impedance	900 ±10% Ohms
Fault-line power (selectable)	Nominally (+) / (-) 45, 55, 100 or 110 VDC at 20 mA
Noise weighting	C-message
Noise range	3 to 90 dBrn
Resistance range	<100 Ohms is SHORT >10,000 Ohms is OPEN
Resolution	100-Ohm steps
Accuracy	±10%

TECHNICAL DATA (continued)

ERROR DETECTOR

System	T1 or T1C (T1 with AMI coding is identified as T1; with B8ZS "clear channel" coding, as T1 CC)
Input level	0.2 to 4.0V pulse
Measurement (selectable)	BPV or B8ZS coding violations Logic errors (w/QRW) Error seconds Burst seconds Error rate
Error seconds	Synchronous method
Error burst	Error rate $>10^{-3}$ or no signal
Error distribution intervals	5 minutes for 2-hour test 1 hour for continuous test

GENERAL

Communications interface:	
Modem	RS-232C connector
Printer	RS-232C connector (includes null modem)
Power	115/230 VAC; 50 or 60 Hz
Temperature	0° to 50°C (+32° to +122°F)
Humidity	95% maximum
Dimensions (excluding handle)	7 in H x 17 in W x 16 in D (17.8 cm H x 42.5 cm W x 40.6 cm D)
Weight	24.5 lb (11.1 kg)

TECHNICAL DATA (continued)

DEFAULT MENUS

When testing is initiated, the 425A-5 uses parameters which are stored in permanent memory. These parameters are displayed on three (3) video pages and can be changed at will. Square brackets [ ] indicate the choices selected when the instrument is first shipped from the factory.

```
DEFAULT DISPLAY PAGE 1                T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  FORM FEED BEFORE PRINT        YES
 *                               [NO]
 *  CLEAR CHANNEL                [NO]
 *                                YES
 *  MEASURE 2 AND 3 LIMITS       [5 TO 7 DB]
 *                                4 TO 8 DB
 *  IDLE MODE PCM                [QRW]
 *                                MEASURE 1
 *  ERROR TYPE                   [VIOLATIONS]
 *                                LOGIC

PRESS DEFAULT FOR PAGE 2
```

```
DEFAULT DISPLAY PAGE 2                T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  OBSCURE TEST ANALYSIS        [REFERENCE]
 *                                RELATIVE
 *  OBSCURE LOWER LIMIT          [-0.5 DB]
 *                                -1.0 DB
 *                                -1.5 DB
 *  OBSCURE UPPER LIMIT          [+1.0 DB]
 *                                +1.5 DB
 *  MAXIMUM STRESS               [DENSITY 4]
 *                                DENSITY 5

          OFFICE LOCATION/MACHINE ID

PRESS DEFAULT FOR PAGE 3
```

```
DEFAULT DISPLAY PAGE 3                T1 QRW
 *  NO CHANGE, RESUME NORMAL TESTING
 *  SAVE CHANGES, RESUME NORMAL TESTING
 *  LINE 1:  [ABCDEFGHJKLM]

 *  LINE 2:  [+ABCDEFGHJKLM-MLKJHGFEDCBA]

 *  LINE 3:  [C]

 *  LINE 4:  [D]

 *  LINE 5:  [E]

 *  LINE 6:  [F]

PRESS DEFAULT FOR PAGE 1
```

5. MAINTENANCE

INTRODUCTION

5.1 Operator maintenance is generally limited to:

1) Replacing fuse
2) Keeping the test set clean
3) Performing the self-test procedure to demonstrate that the test set is functioning properly

SERVICE AND REPAIR

5.2 Service and repair information is available by contacting the Sierra Customer Service Department.

ADDRESS: Customer Service Department
SIERRA - FL JENNINGS
970 McLaughlin Ave.
San Jose, California 95122
Telephone: 408-292-4025
Telex: 172385

When an instrument is to be returned for repair or servicing (whether under warranty or not), obtain packing and shipping instructions, and a Return Authorization number (RA No.) from the Customer Service Department before shipping the test set. IMPORTANT: Please include a written description of the trouble with the instrument when shipping it for service or repair.

Rough handling during shipping occasionally may loosen PC boards in their sockets. Check that all boards are solidly mounted if the set does not operate when first received.

CLEANING

5.3 The instrument can be cleaned with a soft damp cloth squeezed in a solution of 90% isopropyl alcohol and 10% water. Be careful not to moisten any wiring or electrical parts. Do not submerge the test set in the solution. Use another cloth to wipe dry after cleaning.

FUSE REPLACEMENT

5.4 The 425A-5 uses a 2 Amp Slow-blow fuse for 115 VAC or a 1 Amp Slow-blow fuse for 230 VAC. The fuseholder is located on the rear panel. To replace the fuse:

1) Disconnect the power cord.
2) Remove the fuse.
3) Check the fuse rating and whether the fuse is blown.
4) If necessary, replace the fuse.

230 VAC OPERATION

5.5 When shipped from the factory, the power supply of the 425A-5 is connected for 115 VAC. However, the test set is also designed for operation on 230 VAC. In order to change the line voltage setting, follow the procedure below.

> NOTE: The voltage-change card located beside the fuse under the clear plastic cover next to the power cord is not used on the 452A-5.

INSTRUCTIONS FOR CHANGING INPUT VOLTAGE

Step	Description
1	Disconnect the power cord from the test set.
2	Remove the bottom cover of the test set.
3	Move the single-lead connector on the power supply from the pin marked 110 to the one marked 220. (The wire with the connector is identified with a red tag.)
4	Replace the bottom cover.
5	Remove the fuse (located on the rear panel).
6	Check the fuse rating (see 5.4, page 29).
7	Install a fuse of the correct rating.
8	Connect the power cord to a 230 VAC receptacle.

SELF TEST

5.6 The 425A-5 has a built-in self-test function. This function is accessed by pressing SELF TEST.

For proper performance of the self-test function, all plugs must be removed from the front panel.

When this test is initiated, the display is cleared and the message SELF TEST IN PROGRESS appears on the bottom line of the CRT.

First, a diagnostic pattern is written in the RAM, and then it is read for verification. If not verified, the message RAM TEST FAILURE is displayed; the test stops, and the test set is inoperative.

Next, each byte of ROM is read and checked. If not verified, the message ROM n TEST FAILURE is displayed, where n is the number of the ROM; the test stops, and the test set is inoperative.

Following the memory tests, various parts of the operating circuits of the set are tested for performance. As each test is completed, a message will be displayed to indicate either pass or fail. These messages are shown below. If a fail message occurs, it is marked with an asterisk (*) and an audio tone sounds.

If all tests are passed, the display will show this for a few moments. Then the display will revert to the initial presentation.

If one or more of the tests fails, the display will continue to show the indication of failure. The following message appears on the bottom line of the CRT:

IF YOU WANT TO CONTINUE TESTING, PRESS A FUNCTION KEY

If the test set does not pass the self test, it is recommended that the user arrange to have the problem corrected. See Section 5.2, page 29.

SELF TEST MESSAGES

PASS	FAIL
VERIFIED DEFAULT DATA	* DEFAULT DATA DID NOT VERIFY
SERIAL COMMUNICATION CONTROLLER PASSED	* SERIAL COMMUNICATION CONTROLLER FAILED
T1 QRW ERROR FREE	* DOES NOT RECOGNIZE ERROR-FREE T1 QRW
T1C QRW ERROR FREE	* DOES NOT RECOGNIZE ERROR-FREE T1C QRW
VERIFIED T1 ALL ONES	* DOES NOT RECOGNIZE T1 ALL ONES
CORRECT T1 LOGIC ERROR/ BPV COUNT	* T1 LOGIC ERROR/BPV COUNT NOT CORRECT
VERIFIED T1C ALL ONES	* DOES NOT RECOGNIZE T1C ALL ONES
CORRECT T1C LOGIC ERROR/ BPV COUNT	* T1C LOGIC ERROR/BPV COUNT NOT CORRECT
MEASURE 1, REFERENCE LEVEL CORRECT	* MEASURE 1, REFERENCE LEVEL NOT CORRECT
MEASURE 1, DENSITY 4 LEVEL CORRECT	* MEASURE 1, DENSITY 4 LEVEL NOT CORRECT
MEASURE 2 LEVEL CORRECT	* MEASURE 2 LEVEL NOT CORRECT
MEASURE 3 LEVEL CORRECT	* MEASURE 3 LEVEL NOT CORRECT

OPTION SWITCHES

5.7 The 425A-5 offers the user options in three areas:

1) S1 - Baud Rate
2) S2 - RS-232C Interface Format
3) S4 - System Options

NOTE: S3 is not used in the 425A-5.

Options are selected by setting the OPTION SWITCHES. Each is an 8-bit switch located on the Communication Interface (A2) board. Follow the procedure below to change the option switches.

The options available are detailed in Tables 5-1, 5-2, and 5-3.

INSTRUCTIONS FOR CHANGING OPTION SWITCHES

Step	Description
1	Disconnect the power cord from the test set.
2	Remove the card cage cover on the rear panel.
3	Unplug the connector to the A2 board (extreme right hand side).
	NOTE: Each PC Board is identified by a label on the bottom metallic chassis stiffener at the rear of the 425A-5, and also on each board.
4	Pull out the A2 board.
	NOTE: The switch numbers are clearly marked on the board, and the individual switches are marked on each set. An arrow beside switch 1 shows the ON position.
5	Set the option switches as desired.
6	When the switches are set, reinstall the A2 board, being very careful of that the card lines up with the socket pins on the backplane.
7	Plug the connector into the front of the board.
8	Replace the card cage cover.

TABLE 5-1
S1 Option Switch
Baud Rate Setting for Both RS-232C Interface Connectors.

Baud Rate	Bit Switch Number 1	2	3	4	5	6	7	8
50	0	0	0	0	1	1	0	0
75	1	0	0	0	1	1	0	0
110	0	1	0	0	1	1	0	0
134.5	1	1	0	0	1	1	0	0
150	0	0	1	0	1	1	0	0
300	1	0	1	0	1	1	0	0
600	0	1	1	0	1	1	0	0
*1200	1	1	1	0	1	1	0	0
1800	0	0	0	1	1	1	0	0
2000	1	0	0	1	1	1	0	0
2400	0	1	0	1	1	1	0	0
3600	1	1	0	1	1	1	0	0
4800	0	0	1	1	1	1	0	0
7200	1	0	1	1	1	1	0	0
9600	0	1	1	1	1	1	0	0
19200	1	1	1	1	1	1	0	0

TABLE 5-2
S2 Option Switch
Data Format for Both RS-232C Interface Connectors.

Format Item	Bit Switch Number 1	2	3	4	5	6	7	8
ASYNC MODE:								
*	0	1						
WORD LENGTH:								
5 bits			0	0				
6 bits			1	0				
7 bits			0	1				
*8 bits			1	1				
PARITY:								
*OFF					0			
ON					1			
*ODD						0		
EVEN						1		
STOP BITS:								
1 bit							1	0
1½ bits							0	1
*2 bits							1	1

* = factory setting
0 = OFF, 1 = ON

TABLE 5-3
S4 Option Switch
System Options

Option Item	Bit Switch Number 1	2	3	4	5	6	7†	8†
FAULT LINE VOLTAGE SELECTION:								
Displayed	0							
*Not displayed	1							
T1D MENU SELECTION:								
*Enabled		1						
Not enabled		0						
T148C MENU SELECTION:								
*Enabled			1					
Not enabled			0					
9148A MENU SELECTION:								
*Enabled				1				
Not enabled				0				
COMMUNICATIONS PROTOCOL OPTIONS:								
No response [1]					0	0		
Output Bell [2]					0	1		
ACK/NAK [3]					1	0		
*XON/XOFF [4]					1	1		

NOTES:

1 No response transmitted or expected.

2 Transmit Bell Character if invalid control character received; no response if valid control character received.

3 Use ACK-NAK protocol: all messages ended by carriage return; on transmissions, wait for response; retransmission limit = 5.

4 Used when connected equipment has the ability to signal that the data transmission is to be turned OFF and ON.

* = factory setting
0 = OFF, 1 = ON
† = Bit switch not used

PARTS AND ACCESSORIES

5.8 Parts and accessories are shown in Table 5-4.

TABLE 5-4
PARTS AND ACCESSORIES

Sierra Part Number	Description
913200040	2 Amp Slow-blow Fuse (for 115 VAC power)
913200007	1 Amp Slow-blow Fuse (for 230 VAC power)
A03057200	19" Rack Mount Kit
A03631300	Printer Kit, consisting of: AC Operated Printer AC Adapter 6-ft Cable, RJ11 to RS-232C Two (2) Rolls Print Paper Plastic Carrying Case, (4 x 13½ x 10)
921000090	Canvas Carrying Case for 425A-5

APPENDIX A

TESTING A DIGITAL CARRIER SYSTEM

INTRODUCTION

A.1 This Appendix provides a general description of digital transmission systems and maintenance techniques associated with such systems. The information is presented in order to enhance the understanding of the fundamentals of digital signal error detection and T-Carrier fault locating.

All digital carrier systems in common use today can be tested with the 425A-5 DCFA, which is a dual-function instrument designed for use during installation and maintenance. It provides both functions needed for central-office testing:

(a) Error detection, counting, and analysis for either a T1 or T1C signal. T1 systems with standard AMI coding, as well as clear channel with B8ZS coding, are accommodated.

(b) Span line fault-locating for T1, T1C, T1D, T148C, and 9148A systems.

The 425A-5 DCFA may be used with passive filters or filter-amplifiers. The standard fault-locating pair is utilized in the conventional manner, and standard test patterns are used. Test results are analyzed by a microcomputer in conformance with accepted industry practice.

DIGITAL CARRIER SYSTEMS

A.2 The first practical digital carrier system, designated T1, had a single application: connecting two D1 channel banks together in order to provide interoffice trunking. This combination was designed for toll-connecting and EAS trunking applications. Today, many different types of digital carrier systems are in use and the applications have expanded to include both toll plant and subscriber loop multiplexing. In spite of this remarkable growth in the digital network, the maintenance and test procedures of the original concept are still basically sound. The key element of a digital transmission system is the carrier span.

Span Concept

A digital line is formed by interconnecting spans between central offices in such a way as to reach the destination office in the most efficient manner. Typically, in metropolitan areas a line may include five or more individual spans, as shown in Fig. A-1. The route shown, Office A to

Office D, is a backbone route but it is readily apparent that service between the destination offices could be provided by alternate routes. A span is an integral unit which extends from DSX to DSX and may be interconnected with any other span at those points. This basic design concept allows complete flexibility, not only in devising an efficient trunking plan, but also in restoration of service in case of failure or facility disruption in a route.

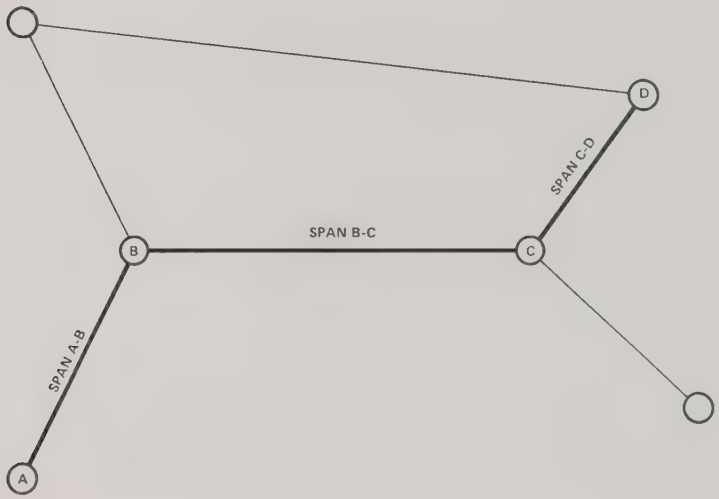

Fig. A-1
T-Carrier Span Concept

Since all lines in a given span are the same, as far as the office interface is concerned, an extra line is provided to serve as a spare. When such spare, or maintenance, lines are patched together to parallel a high density route it is referred to as a backbone maintenance line. Fig. A-2 shows the relationship of these three types of lines:

Working line: A digital carrier which is carrying traffic, thus is connected to a channel bank, digital switch terminal, subscriber loop multiplexer, or data bank.

Maintenance line: A span line which is used as a spare between two central offices to take over for a failed line in that span. Maintenance lines are normally driven with a QRW signal via a bridging repeater. The bridging repeater makes it possible to perform a hot patch which does not interrupt normal service.

Backbone line: A spare line which is configured the same way as a working line, i.e., an express spare line. The purpose of such an arrangement is to provide quick restoration of service. Backbone lines are driven the same way as other maintenance lines.

It is extremely important that all spare lines be driven with a bipolar signal at all times. This serves two purposes:

(1) it prevents line repeaters from oscillating or being triggered by crosstalk noise, and

(2) the line performance can be easily monitored with an error detector.

The preferred signal for this application is generated by a Quasi-Random Signal Source.

The basic objective in engineering digital carrier systems is to provide an error rate of less than $1x10^{-6}$. If a system is made up of three spans, then each span should have an error rate of approximately $3x10^{-7}$. Many services require a lower error rate and in actual practice most T-carrier spans have a considerably lower rate than this objective.

The first step in repairing a faulty carrier system is to sectionalize the problem, that is, identify the particular span line in the tandem connection which is not functioning properly. This process involves the use of an Error Detector and is discussed in detail in Section A.3. When

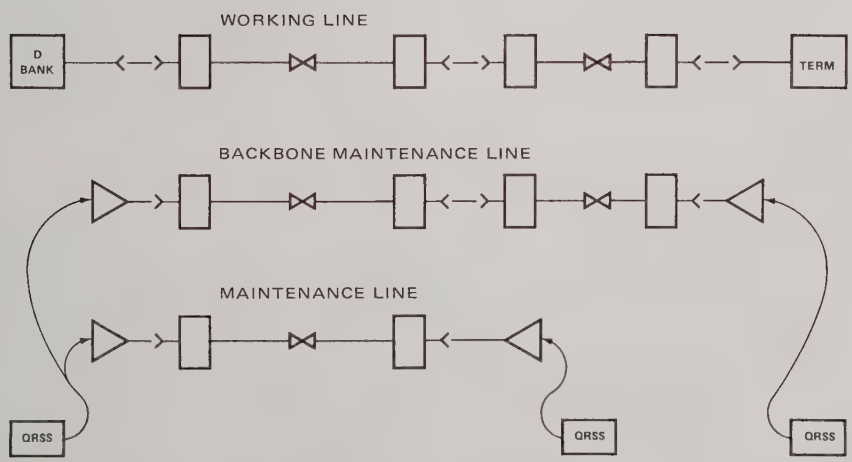

Fig. A-2
T-Carrier Lines

this is accomplished, the individual repeater sections can be checked sequentially using the fault-locating technique. The span concept in the design of digital carrier systems provides for both rapid restoration of service and systematic isolation of the problem.

Span Line Description

A span line includes Span Terminating Equipment in each central office (CO) and Line Repeaters installed in Apparatus Cases in the field. Line Repeaters are powered by DC simplex current supplied and regulated by the span terminating equipment. Correct current is critical to the operation of repeaters and is always checked first when trouble occurs in a span line. The primary elements of a typical span line are shown in Fig. A-3.

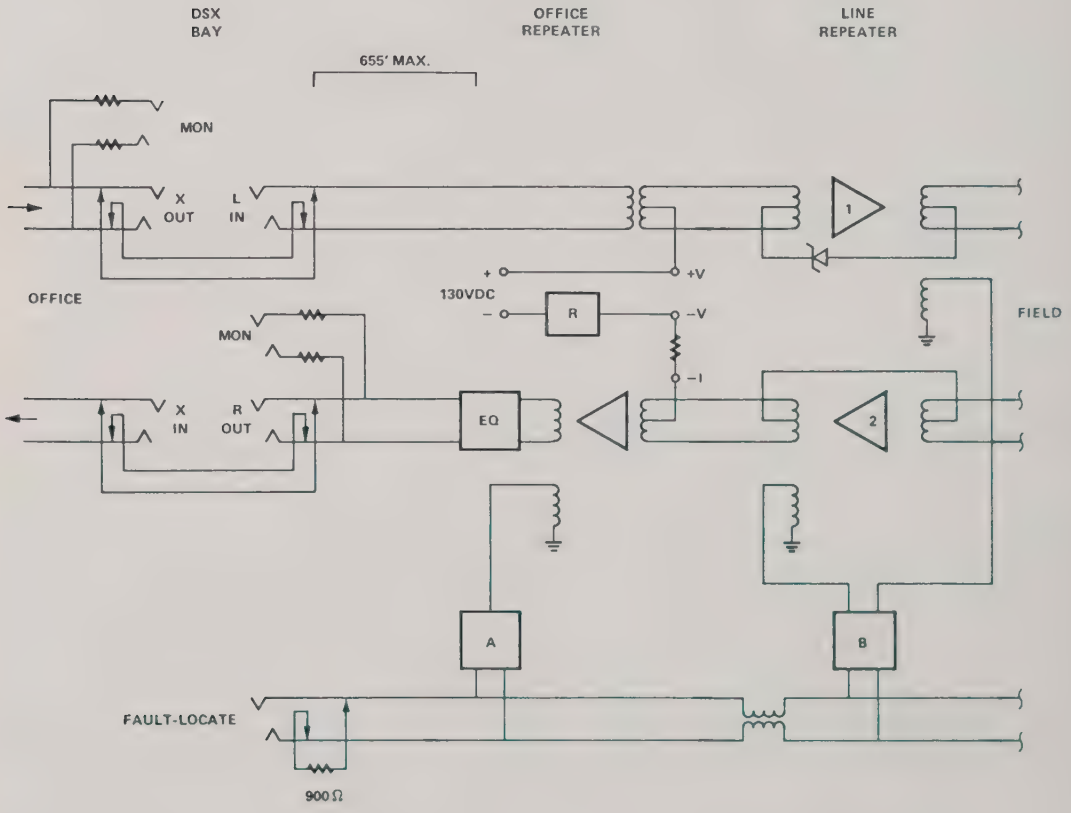

Fig. A-3
Elements of a Span Line

The office interface to a span line consists of L IN, R OUT, and MONITOR jacks. The jacks may be located in a DSX or Office Repeater (ORB) bay or even be part of the office repeater itself. These jacks are cross-connected to another set of jacks which are wired to the terminal equipment (D-bank, Digital Interface Frame, etc.). The jack access arrangement makes it possible to temporarily connect any terminal equipment to any span line, patch-off a failed line, or connect test equipment for the purpose of troubleshooting or performance monitoring. The Digital Signal (DS) location is a standard level point and may be at the office repeater bay or DSX bay, if provided. Most offices have a DSX bay, which is designed specifically to facilitate administration and maintenance of digital carrier systems.

Office wiring between the ORB and the DSX bay is controlled so that the pulse shape and amplitude at the cross-connect location will conform to the requirements of a standard cross-connect point. Fig. A-4 shows the nominal T1 pulse shape. The T1C pulse is similar in amplitude and shape but does not have an afterkick. Channel banks or terminals have equalizers in the transmit side which are selected to provide a standard amplitude/shape at the DSX point.

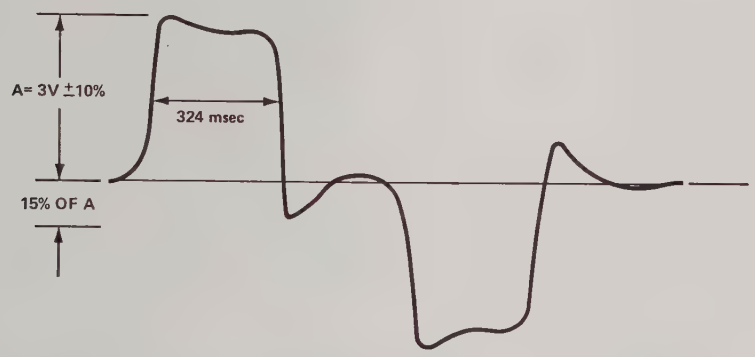

Fig. A-4
Pulse Shape at DSX

MONITOR jacks are provided so that bridging measurements can be made on all incoming signals at the DSX bay. At these jacks, series resistors (usually 430 Ohms) are inserted in each lead of the balanced circuit. When a terminated instrument is used for measurment, the signal level across the termination is 1/10 the actual voltage, or approximately 20 dB down. This gives a bridging loss of approximately 0.5 dB.

> NOTE: When using the MON jacks, a short (6 ft) patch cord should be used and the instrument should be terminated. Reflections within an unterminated cord can result in erroneous indications on the test set.

The Office Repeater serves to interface the office equipment and the field facilities. In standard T-carrier systems, the transmit side includes only level coordination pads, surge protection, and a simplex transformer to apply current to the field cable pair. The receive side includes the above, plus a regenerator to restore the low level signal to standard level, and a simplex current regulator. Test points are provided to measure line current and also to check regulator voltage drop. Some Office Repeaters, but not all, also have an equalizer to compensate for office wiring losses up to the DSX location.

Digital systems using signal encoding other than Alternate Mark Inversion (AMI) also have a scrambler and coding circuits plus additional maintenance access. These are discussed later in this section.

The Line Repeater includes two regenerators plus a common power supply. Each regenerator has a high impedance winding on the output transformer which is used to derive the fault-locating signal. Line Repeaters may be bidirectional (one repeater provides regenerators for both directions of the same system), unidirectional (both regenerators work in the same direction, thus are used for one side of two systems), or wired bidirectional where the repeater is built as a unidirectional device and the case wiring is such that it is used for the two directions of the same system. T1C and T1D are provided in this format, and in some cases, T1. From a CO troubleshooting point of view it matters very little how the line repeaters are wired except to remember that unidirectional systems have a power mate when patching off facilities for field maintenance.

The smallest element in the carrier system is the repeater section. This is defined as the regenerator plus the input cable section associated with that direction of transmission. Fault locating (see Section A.4) from the CO can be used to pinpoint trouble to one such section but not to determine whether the problem occurs in the repeater or the cable pair.

Digital Carrier Line Coding

The original T-carrier, T1, uses a simple AMI line coding scheme. A digital bit stream is transmitted by inverting every other mark, giving the bit stream a +/- format. Such a signal has many of the attributes of an AC signal; the average level is 0 volts and it can easily be transmitted by transformer coupled devices. The power of a random signal transmitted with an AMI code will be concentrated at the Nyquist frequency (half the bit rate) and have a null at the clock frequency. The spectral density of various systems is illustrated in Fig. A-5 for comparative purposes. For engineering purposes, line loss calculations are made at the Nyquist frequency, 772 kHz for T1 and 1.576 MHz for T1C.

> NOTE: AMI line coding provides only two levels of information, every mark is transmitted separately as a (+) or (-) pulse and a space is an absence of such a pulse. To the receiver, it makes no difference whether a pulse is (+) or (-), it is always interpreted as a mark.

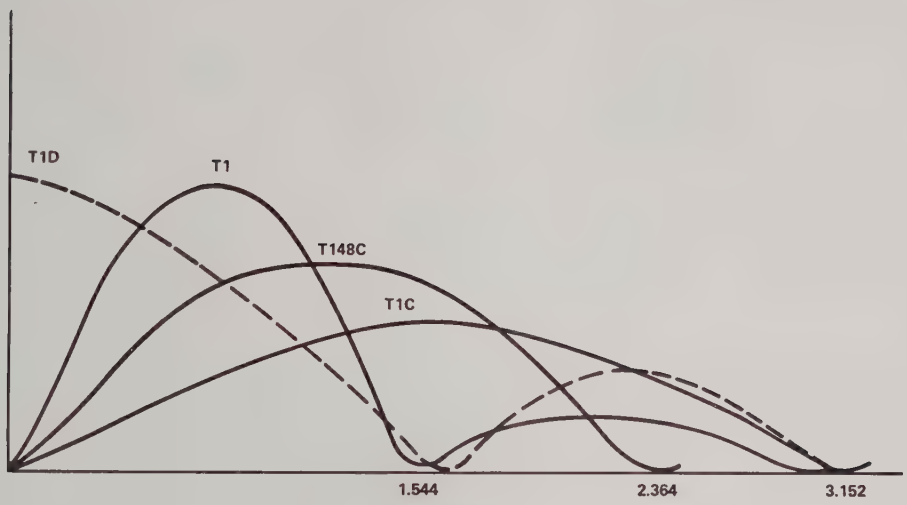

Fig. A-5
Spectral Density of Digital Systems

The line bit rate can be reduced by processing the data stream in a more complex manner than is done in the T1 and T1C systems. Ternary coding is used in the T148C system in a 4B3T format (4 binary to 3 ternary conversion) to reduce the line rate from 3.152 to 2.364 Mb/s. As shown in Fig. A-6, the data stream is processed by encoding four sequential bits into three pulses, using all three levels (0, +, -) in a unique arrangement. As an example, 1011 becomes 0, 0 and 0100 is 0, -, +. Many 4B groups can assume two different 3T formats, 1011 could also be 0, 0, -, the purpose being to keep the average signal at 0V. The resulting signal contains bipolar violations (BPV) which in the case of T148C can accumulate to less than five in either direction. The line spectrum contains somewhat more energy than for an equivalent AMI system. The line repeaters have a more complex ALBO/equalizer since the signal lacks redundancy which exists in AMI systems and must be equalized more precisely.

The 9148A carrier system developed by GTE Lenkurt uses a modified duobinary line coding scheme. Duobinary transmission reduces the bandwidth requirements by one half and, by modifying the coding rules somewhat, AMI transmission is retained. The signal is developed by first scrambling the T1C input in order to provide more uniform pulse density. The signal is then split into two 1.576 Mb/s bipolar bit streams, one stream is shifted half a time slot, then the two streams are recombined. The result is an AMI signal with pulses of either 50-percent or 100-percent duty cycle. The polarity of the original pulses is retained. (The illustration in Fig. A-6 ignores the effects of the scrambler.) The signal must be carefully equalized in order to extract the 3.152 MHz clock since there is very little energy at the Nyquist frequency.

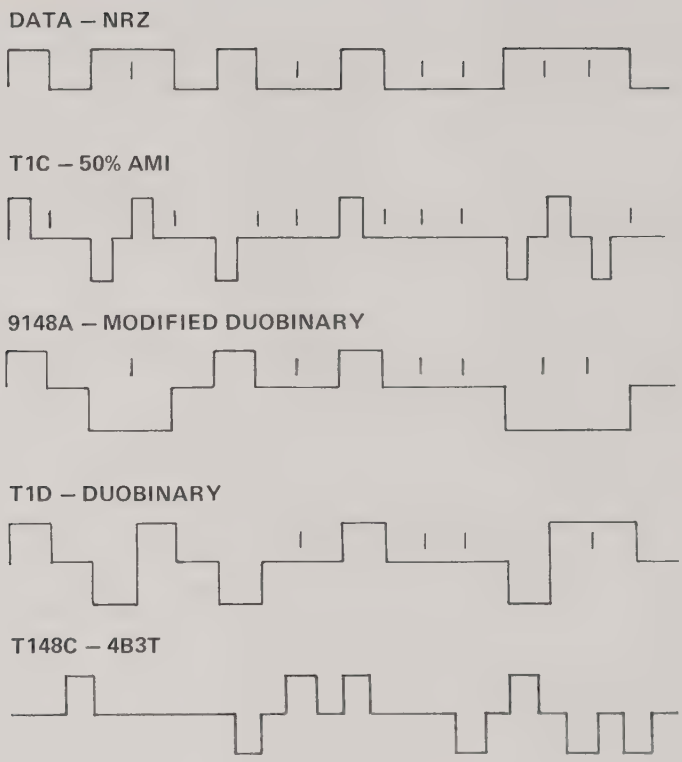

Fig. A-6
Digital Carrier Signals

The T1D employs true duobinary transmission. This scheme uses all levels available (0, +, -) uniquely, but does not allow any transitions through a level. In other words, a mark is always followed by either a mark of the same polarity or a space--never a mark of the opposite polarity. The polarity of the mark is determined by the number of spaces which preceded it. An even number of spaces makes the mark the same polarity as the preceding mark, an odd number makes it the opposite polarity. The resulting line signal has a power maximum at DC and a null at the Nyquist frequency. In practice, the low frequency components are removed by filtering, then restored in the repeater by using quantized feedback. Repeater design is complex and based on large scale integration technology.

ERROR DETECTION

A.3 When information is transmitted in digital form, signal degradation can be measured as errors--extra pulses or deleted pulses. Noise, attenuation and phase distortions, crosstalk, and intermodulation distortion have meaning only in the sense that these impairments may cause errors. The effect of impairments stops at he next regenerator, the output of which is a perfect digital signal. Errors, of course, will be propagated down the line and are in effect additive.

In order to regenerate the digital signal, the repeater must be able to correctly detect pulses in the presence of all impairments. Fig. A-7 illustrates the two requirements for this detection process:

(a) The amplitude of a pulse must exceed the slicing level. Noise, crosstalk, etc. can instantaneously reduce the level of a MARK, or increase the level where a SPACE should occur.

(b) This has to occur at the exact time of the clock pulse. Intersymbol interference has the effect of changing pulse spacing, and any jitter in the clock itself may shift the detection crosshair.

A good measure of the ability of a detector to perform this critical task is the eye opening. An open eye indicates that the crosshairs are in a clear area, and the detector can correctly reproduce the input signal. An eye pattern is obtained by applying the input (data) signal to the VERTICAL amplifier of a scope which is triggered by the clock pulses. It represents all possible signal transitions, which should not occur at the detector crosshair location.

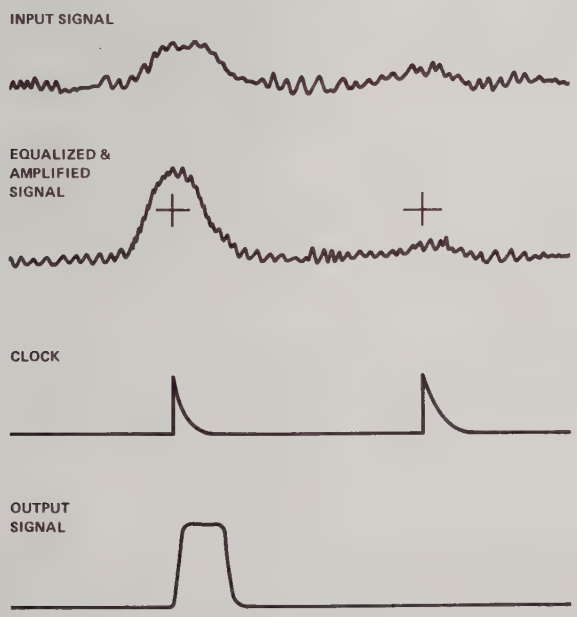

Fig. A-7
Signal Regeneration

When a digital transmission system is carrying live traffic, the pulse pattern is entirely random and connot be predicted. Thus, there is no practical way of monitoring the pattern for errors. In data transmission, various techniques (the most popular being a simple parity check) can

be used to examine the content of the received message and determine whether it contains errors. No such techniques have been implemented for carrier systems. For maintenance purposes, it is necessary to be able to monitor a bit stream, without knowing what its content is, and be able to tell whether it contains errors or not. This is done by using a detector which knows what the line coding rules are.

Bipolar Violations (BPV)

For T1 and T1C, the line coding rule is very simple; marks are transmitted as "ones" with the polarity opposite from that of the preceding mark and spaces are transmitted as "zeros." Thus, a simple flip-flop detector can be used to find errors (see Fig. A-8). Single errors will always cause a violation of the bipolar rule, regardless of whether the violation is an extra pulse, or the pattern is wrong because the preceding mark was obliterated. Multiple errors, occuring in succession, will not necessarily violate the AMI rule, thus may go unnoticed. Errors typically occur at random and will always cause some single errors. This is sufficient to determine that a given line, span, or repeater section is not functioning correctly.

Digital carrier systems which use other line coding schemes have provision for inserting BPVs on the T1C (office) side when line coding violations are detected. Office repeaters for ternary, modified duobinary, and duobinary coded systems have on-board code violation monitors which perform this task. Thus, insofar as CO testing of all baseband digital systems is concerned, monitoring and measurement of BPVs on line traffic equals a measurement of errors.

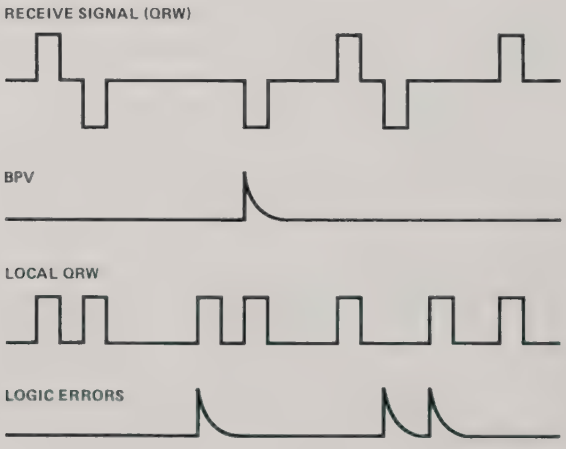

Fig. A-8
Errors

The Quasi-Random Word (QRW)

Higher order transmission systems which use multiplexing to combine several T1 bit streams (an M13 creates a 44.736 Mb/s signal by combining 28 T1 signals) have elaborate error detection circuits but it is not possible to use the error insertion technique used by a line code converter such as a T1D office repeater. The demultiplexed T1 bit stream from an M13 is always true bipolar, even if the data content is totally erroneous. Thus, in system arrangements involving any higher order transmission, isolating the source of errors requires an out-of-service test using a known pulse pattern.

The best test pattern simulates line traffic but is also long enough to contain virtually all combinations of "ones" and "zeros". Such patterns are referred to as pseudo- or quasi-random, because the sequence appears to be random, but it repeats and can be predicted by measuring equipment. The standard Quasi-Random Word (QRW) used for testing baseband digital facilities is 1,048,575 bits long and contains sequences as long as 20 "ones" and 19 "zeros". For T1 applications, pulse stuffing is used to limit the number of consecutive "zeros" to 14. The definition of this QRW is a pattern developed by a maximal length 20 stage shift register with feedback taken from the 17th and 20th stages. All T-carrier test sets which have QRW capability use the same pattern and are compatible.

> NOTE: Because a T1 QRW contains stuffed pulses, it is not identical to the T1C QRW even though both are generated by the same shift register circuit.

When a QRW is used as a test pattern, both individual errors and bursts can be measured. The receiver looks for a particular sequence of marks and spaces and if coincidence is not measured at any clock pulse, an error is indicated. Errors measured in this fashion are referred to as bit or logic errors (see Fig. A-8).

The QRW is generated in the receiver by exactly the same type of circuit that is used in the transmitter with one additional requirement. It must be possible to load the shift register with the incoming signal so that the output will be synchronized. When this task is accomplished the feedback loops are restored and bits from the shift register can be compared one by one with those of the incoming signal. A high error rate usually initiates another load cycle to ensure that such errors are not the result of an out-of-sync condition. Fig. A-9 shows a QRW receiver in simplified form. The output from the shift register can be taken from any stage but the incoming signal must be delayed an equivalent amount prior to comparison.

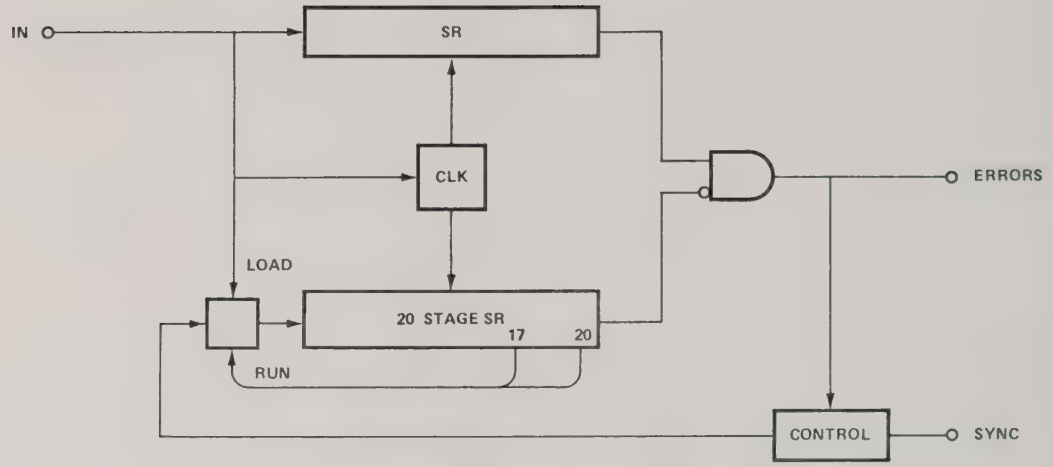

Fig. A-9
QRW Receiver

Performance Monitoring

In most troubleshooting work, a simple BPV monitor provides sufficient information to find the source of trouble. A solid errors light means trouble and occasional flashes can be ignored. While this type of monitor is quite adequate for field use, it is becoming increasingly necessary to count errors in central-office testing. Spans which are nearing the design limit in capacity will have lines which begin to approach an error rate of 1 in 10^6 bits. In such cases the difference between a good and a marginal line is not whether a light is on or off but rather the difference between a count of 15 or 25 errors during a 10-second test. Other applications which require error counting include acceptance testing of new facilities, field trials of new equipment, and routine quality checks. The 425A-5 DCFA counts both BPVs and logic errors and has a unique feature designed specifically for long term tests. For two-hour and continuous tests, error counts are maintained in a distribution table which shows the number of errors accumulated in each five-minute or one-hour segment. This makes it possible to determine the background error rate, even if some severe disturbance such as a power fault or electrical storm, caused a high count during a short period of time.

In data transmission, any error, whether 1 or 100, in a given block of data will result in retransmission of the entire block. A useful measure of performance for such an application is the error second. A count of error seconds (or errored-seconds) is simply a measure of how many seconds during the test had at least one error in transmission. This

can be measured in two different ways, either using an internal clock to establish one-second blocks or by blanking the second following an error. The latter synchronous technique is used in the 425A-5 DCFA because the count does not depend on the timing of clock cycles. Therefore it is repeatable with different instruments or at different locations. Fig. A-10 shows the relationship of error seconds to error events.

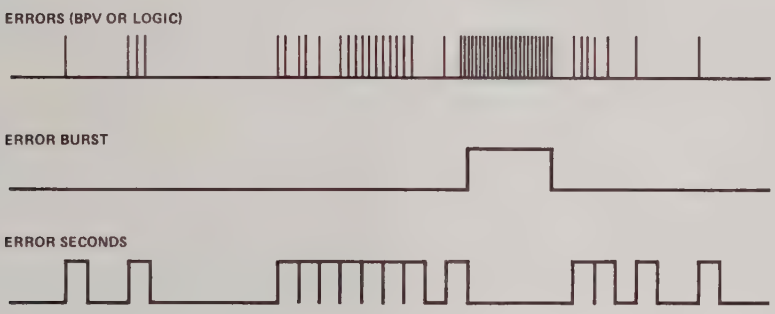

Fig. A-10
Error Measurement

Very high error rates will cause a digital terminal to lose synchronization and initiate a carrier group alarm. This occurs at an error rate of approximately 10^{-3}, or one error in 1000 slots. The 425A-5 DCFA checks the error rate in each counting block (100 msec) and, if it exceeds 10^{-3}, increments the burst-seconds counter by 0.1 seconds. The error count for the burst is discarded so as not to contaminate an otherwise valid count. Periods of lost signal during a test are also accumulated by this counter: therefore the burst seconds timer accurately shows the periods during which a digroup terminal would have failed to stay on line.

Sectionalizing Line Trouble

The error analysis described previously is usually made first on the overall connection--possibly as a result of a CGA generated by the terminal equipment. When this occurs, the first task is to restore service by substituting a backbone maintenance line for the failed working line. The error analysis is then made with a QRW applied to the span line in order to verify that the line cannot carry traffic.

The next step is to sectionalize the trouble to a particular span by using error detectors or counters, as shown in Fig. A-11. This process involves a certain amount of coordination with several offices and may well be a time consuming task. A no-pulses type of problem may be easy to find. Marginal performance--or time related phenomena--may require careful analysis of all the data provided by the 425A DCFA. Once the troubled span is found, fault locating is used to pinpoint the problem to a particular repeater section.

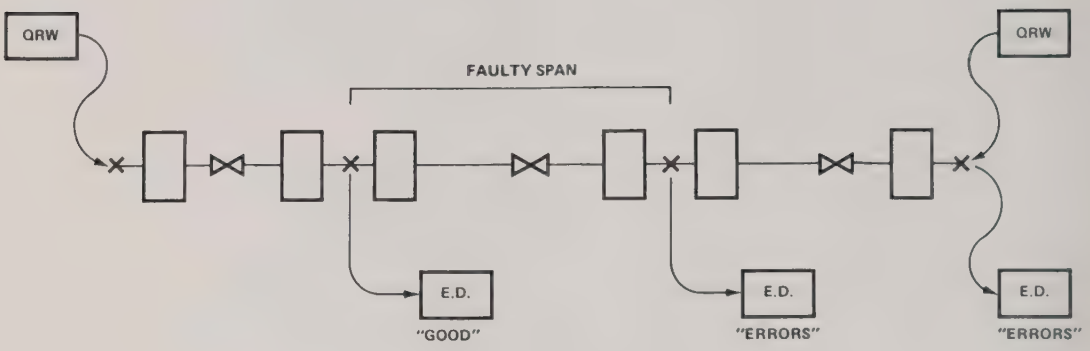

Fig. A-11
Sectionalizing Line Trouble

SPAN LINE FAULT LOCATING

A.4 Digital carrier systems have a built-in fault-locating arrangement. This makes it possible to isolate a span line trouble to a single repeater section by testing from the central office. Since T-carrier repeaters are located only a mile apart, and often in places difficult to service, this ability can be most useful. Standard fault-locating equipment is configured to test in the TRANSMIT direction, however, arrangements with manual or automatic loop-around capability allow two-way testing. Since repeater sections are in series, only the first trouble in the direction of fault locating can be identified.

System Description

The fault-locating subsystem consists of a high impedance output winding on the regenerator, a low input impedance bandpass filter in each repeater case, a loaded VF pair to which all filters are bridged, and an appropriate test set. The high impedance windings of all regenerators in an apparatus case are tied in parallel to the filter input, except in the case of loop-around operations where separate side-1/side-2 filter inputs are provided. A basic system is shown in Fig. A-12.

The test set generates a special fault-locating signal pattern which contains an audio component at a specific frequency. The fault winding on the output transformer of the regenerator transfers this audio signal to the filter which passes the tone through to the fault-locating pair if it falls within the passband of the filter. The tone is transmitted back to the test set where the level is measured and checked against the expected level. Several types of test signals are available, from a straightforward go/no-go test to a complex series of measurements used to evaluate marginal performance.

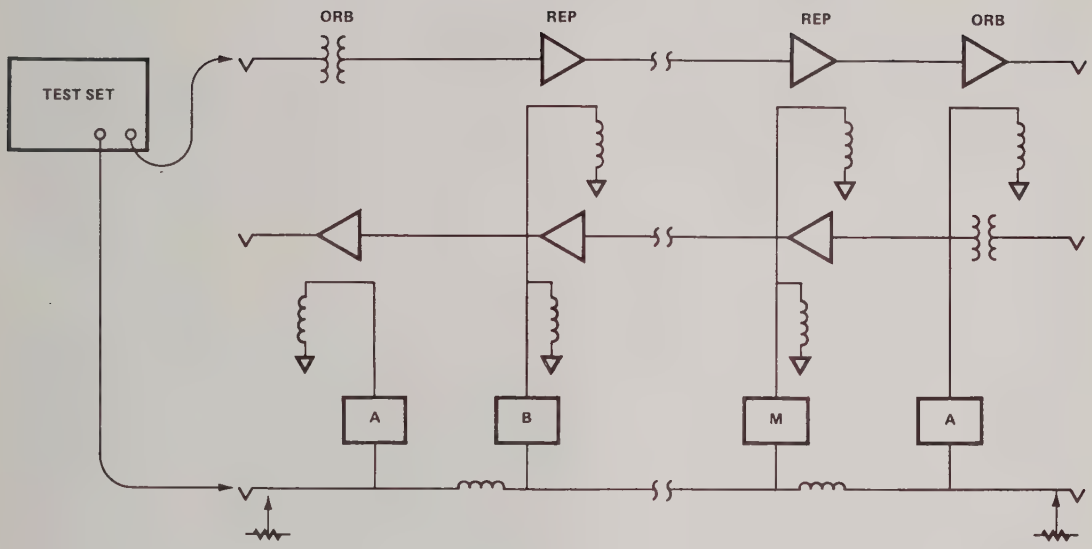

Fig. A-12
Fault-Locating System

To test a specific repeater, the test set is tuned to the frequency of the filter in that particular apparatus case. The T-carrier system used in North America provides 12 unique frequencies, coded A through M, as listed in Table A-1. The same code, usually M, can be assigned to both office repeater locations, thus, there are enough choices to cover 11 field locations. For longer spans, additional fault-locating pairs can be provided and the same codes reassigned to the additional locations. Amplifier-filters, which are activated by applying voltage to the fault-locating pair at the CO, can be installed in a (+) and (-) arrangement to double the number of filters on one fault line.

TABLE A-1
FILTER FREQUENCY AND LEVEL

FILTER CODE	FREQUENCY HZ	LEVEL* dBm
A	832	-62
B	928	-61
C	1049	-59
D	1206	-58
E	1340	-57
F	1508	-56
G	1722	-54
H	2008	-53
J	2193	-52
K	2413	-51
L	2680	-50
M	3017	-49

*50 regenerators

Amplifier-filter output is -32 dBm for all codes

Fault-locating Signal Patterns

The input to the bandpass filter is a composite of all bipolar signals which are being transmitted in the span. Except in the case of T1D, these signals have no components in the audio spectrum; the output of the filter is essentially quiet. T1D has considerable energy in the voice-band, even with transmit filtering, and each system will contribute some audio components. Although specific tones are not present, a high background noise level does occur. Typical values will be in the order of 45 dBrnC. Since the receive level of a tone from a passive filter may be as low as -65 dBm, the signal-to-broadband (3 kHz) noise ratio will be in the order of -20 dB. Narrowband detection techniques are required to produce usable results under such conditions.

The conventional fault-locating signal consists of a series of trios, each of which comprises a bipolar pair plus an extra pulse. The extra pulse alternates from a (+) violation to a (-) violation at a selected audio rate, as illustrated in Fig. A-13. For purposes of fault-locating, the bipolar pair cancels out, but the extra pulses provide an average energy which results in an audio tone at the frequency of the +/- crossover rate. The figure shows the tone to be in phase with the pulse pattern. In actual practice they are not, since the loads are reactive, not purely resistive.

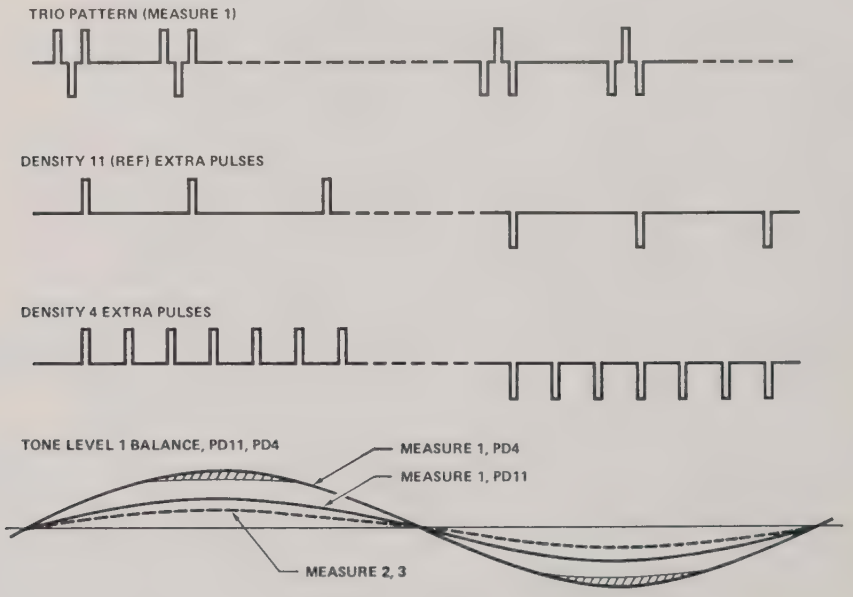
TRIO PATTERN (MEASURE 1)
DENSITY 11 (REF) EXTRA PULSES
DENSITY 4 EXTRA PULSES
TONE LEVEL 1 BALANCE, PD11, PD4
MEASURE 1, PD4
MEASURE 1, PD11
MEASURE 2, 3

Fig. A-13
Fault-Locating Signals

The basic fault locating pattern is referred to as the Measure 1 (M1) signal. It consists of (+) trios in a half cycle followed by (-) trios in the other half cycle. The Reference density is one trio in 11 slots, or 3 pulses followed by 8 spaces. The density can be increased by reducing the spaces between trios one step at a time until the maximum density of one trio in four slots is reached. The level of the audio tone produced is directly proportional to the number of extra pulses in the cycle.

A variation of the basic signal is provided to check the balance of the two detectors (+ and -) in the regenerator. These signal patterns, referred to as Measure 2 and Measure 3, consist of trios in a half cycle followed by bipolar pairs in the other half cycle. (M2 has + violations, M3 has -). Since these patterns provide only half the audio component in the digital signal, the tone level should fall 6 dB below the reference. Equally important, since the tone results from pulses regenerated by only one side of the detector, the difference between the two levels is an excellent measure of the balance of the detector.

T1D Signals

In conventional T-carrier systems, the trio pattern generated by the test set is applied directly to the span line via the office repeater. The T1D office repeater incorporates both a scrambler and a coder, thus a different approach must be adopted. The scrambler is disabled by applying +5 VDC simplex to the R IN circuit and the fault-locating signal pattern is designed in such a way that, after encoding into the duobinary format, it produces the same type of audio tone as does the trio pattern in other systems.

The T1D fault-locating pattern is a 64 bit word which consists of eight 8-bit bytes. Two types of bytes are used: the B byte produces an audio component, the A byte is a balanced signal and is used as a filler in the word. At every half cycle point the unbalance component is turned over, from (+) to (-) and vice versa by inserting an extra space at the end of that particular word. The same frequencies are used for T1D as for conventional systems. Fig. A-14 shows the composition of the T1D pattern, and Fig. A-15, the byte structure of the word.

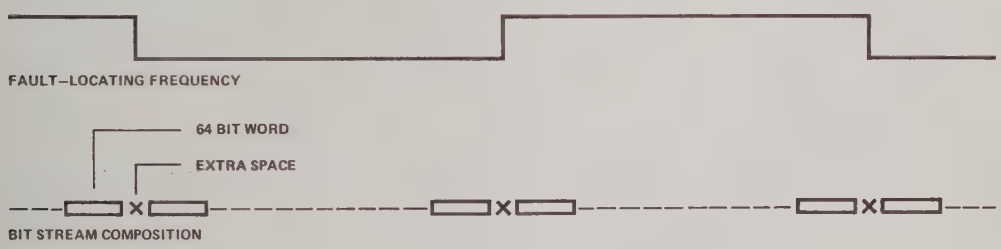

Fig. A-14
T1D Fault-Locating Signal

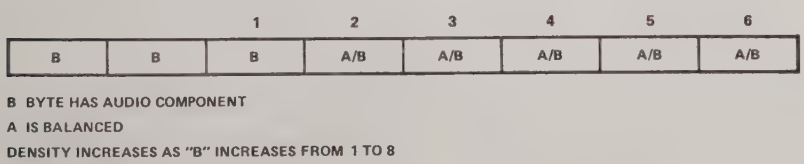

Fig. A-15
T1C to Duobinary Coding

The audio component in the signal can be increased in steps by increasing the number of B bytes in the word. Eight such steps are available and at maximum level the word would be composed of only B bytes. Fig. A-16 shows how the T1C input signal to the office repeater is encoded to a duobinary signal with an audio component.

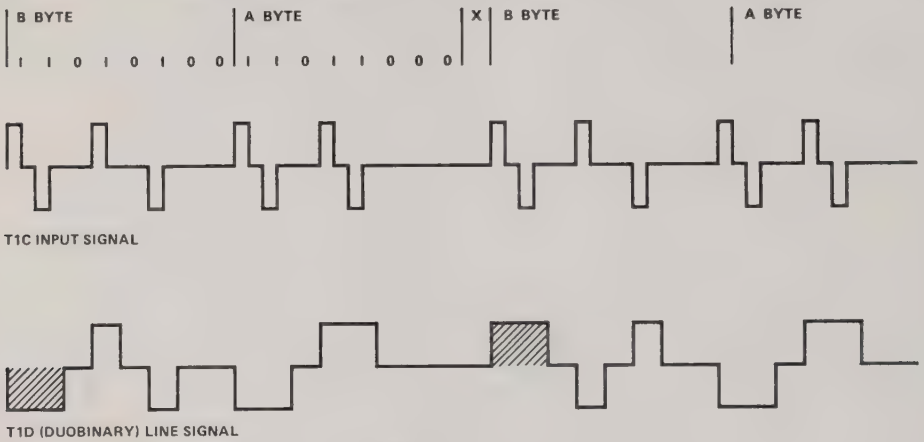

Fig. A-16
T1C to Duobinary Coding

Transmission Test

The basic fault-locating test is used to check the ability of the facility to transmit a digital signal. The purpose is to locate catastrophic failures of the line--such as a dead repeater, cable pair grounds or severe crosses, etc. The Measure 1 pattern at the reference density (11) is used first, then if a signal is received from that particular repeater, a level check for M2 and M3 is made. The M1 REF tone level should be within 6 dB of the value recorded for that span line and the M2, M3 tones should be 6 dB below the M1 level. The level difference between the M2, M3 signals should be less than one dB.

If recorded levels are not available, it is possible to calculate the expected receive level using the data shown in Tables A-1 and A-2. It should be noted that the frequency being transmitted may be returned through adjacent (flanking) filters at levels only 10-15 dB below normal. Occasionally, this is mistaken for a valid return.

TABLE A-2
CABLE LOSS
(dB/1000')

GAUGE	LOADED		UNLOADED	
	A	M	A	M
19	.08	.11	.22	.39
22	.15	.18	.32	.56
24	.23	.26	.40	.75
26	.33	.36	.50	.93

NOTE: A and M refer to the lowest and highest fault-locate frequencies, respectively.

The usual procedure is sequentially to interrogate each repeater section, starting with the one nearest the office from which the test is being made. The defective section is the first one from which a normal tone level is not received. If no clear-cut defective indication is received from this test, such as would be the case for most problems of marginal operation, a more detailed pulse density test is then required.

Obscure Trouble Analysis

When a pulse pattern with extended unbalance is transmitted on a digital facility the extra pulses create an offset voltage in the regenerator. This effectively biases the detector which will begin to make errors if the offset is great enough. The fault-locating signals provide a stepped control of this offset voltage by increasing the density of the unipolar pattern. This means of increasing the stress on the repeater is used to evaluate qualitatively the performance of a repeater section.

Fig. A-13 illustrates in simple terms the relationship between pulse density and tone level. This tone level depends directly on the presence of the extra pulses at the output of the repeater. If the regenerator fails to duplicate the original signal exactly, the level will be less if fewer pulses are produced. A reduction in level with increasing stress is more typical than is an increase in level. The shaded area in the figure corresponds to such a reduction in level.

> NOTE: The normal level increase for each density step is shown in Table A-1.

Test sets designed to perform the pulse density test have built-in level-vs-density compensation such that the reponse of a good repeater will be flat. Sierra sets are designed to display test data in relative terms: that is, as +/- deviations from the expected levels. This makes it easy to use the results. Fig. A-17 illustrates how the rising level with density is compensated to provide a flat reading. The lowest density (highest number) at which the repeater response exceeds preset limits is the stress point for that repeater (PD 5 for T1 and T1C in Fig. A-17). The limits in the 425A-5 DCFA are set at +1.0 dB and -0.5 dB.

> NOTE: A good repeater, working under ideal conditions will not have a stress point.

Initially, fault-locating test sets were designed to match the characteristics of early production T1 repeaters. These repeaters are based on discrete logic design, and the tone level does not increase as rapidly as would be expected from a theoretical analysis, as the pulse density is increased. Current production repeaters, based on integrated circuit design, have a much improved output circuit and the response is much closer to theoretical values. The difference between an early production T1 repeater and a low-power mini-repeater is approximately 2 dB at Pulse Density 4. The 425A-5 DCFA has three sets of compensation curves: DISCRETE T1, STANDARD (T1, T1C, T148C, and 9148A), and T1D so that all systems can be matched precisely.

NOTE: If a discrete repeater (T1) is tested with a standard setting, a (-) stress point will occur at a much lower density than would be the case if the correct setting were used. Conversely, using a discrete setting for an integrated design repeater would result in an early (+) stress point. For lines with a mixture of repeater types, it is important to use the correct settings in order to obtain correct test results.

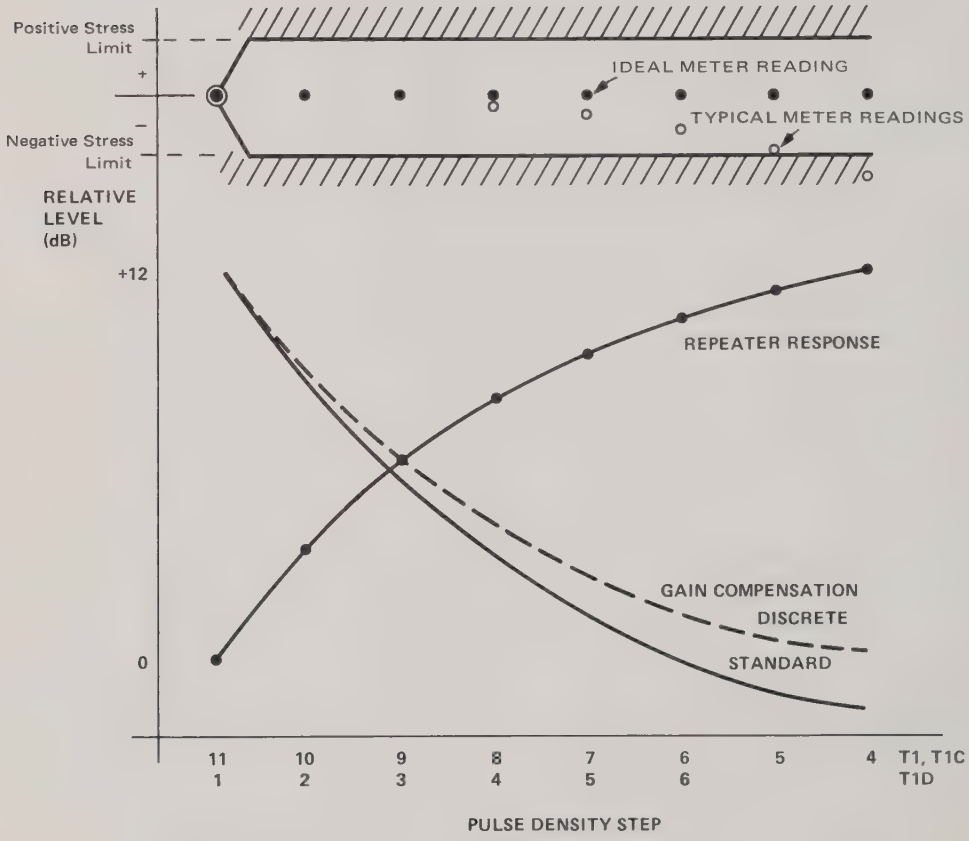

Fig. A-17
Pulse Density Compensation

Stress points may be determined by using the reference method of setting level tolerance limits or the relative method. With the first method, shown in Fig. A-17, the limits for all densities are fixed by the level at the reference density (PD 11 for T1 and T1C). This requires absolute conformance; thus, the compensation curve in the test set must exactly match a good repeater's performance. This method is more sensitive to signal degradation and has less tolerance for variation in repeater performance. With the relative method, limits are fixed by the

level at the preceding density. This will allow considerable drop in level, provided that such changes occur in a gradual manner. A stress point is the result of an abrupt change in level between two adjacent pattern density steps. This method yields good results with certain types of repeaters--especially early production units. The 425A-5 DCFA has provision for both methods of establishing the location of stress points--on a switch selectable basis.

Fig. A-18
Repeater Stress Points

The first step in carrying out an obscure trouble analysis is to plot the stress points of all repeaters in the span line, as shown in Fig. A-18. The location of the stress points, relative to each other, is then evaluated in accordance with a particular set of rules, or algorithm. These rules identify the first section in the span which is most likely the cause of marginal operation. The process is as follows:

(1) A good repeater, tested properly, could not have a stress point; however, the fault-locating pattern does degrade somewhat as it is transmitted from repeater to repeater. A gradual drop in level, especially on very long systems is normal, and thus the stress points will also gradually drop. In the figure, if the line consisted of repeaters A through F only, the stress plot is normal. If such a line is known to be faulty, the problem is most likely at C, the first location to show a stress point.

(2) The largest change in stress point, in an otherwise normal picture, indicates the faulty section. If the line shown included repeaters A through H, this trouble would most likely be at G.

(3) If the plot of stress points shows a reversal, the section at which this occurs is faulty, i.e., at J in the complete line shown.

The 425A-5 DCFA automatically applies an algorithm similar to the above to identify the marginal repeater section.

Equipment Considerations: (1) Fault-Filter Response

Standard fault-locating filters have a broadly shaped response curve which has less than 20 dB attenuation at adjacent frequencies. A missing filter will still show up, approximately 17 dB low in level, if the line includes both flanking filters. Although this is well below the normal level, such readings can easily be mistaken for valid responses if the correct level is not known. If span line records are not available the level can be estimated on the basis of data such as is shown in Tables A-1 and A-2.

> NOTE: Tone levels for record purposes are always measured with a Measure 1, density 11 (reference) signal.

In contrast to passive filter response, amplifier-filters have a sharp cutoff characteristic. The attenuation at adjacent frequencies is a minimum of 35 dB. Fig. A-19 shows the response of the two types of filters. The output level of powered filters is also uniform for all frequencies at -32 dBm (fully equipped case).

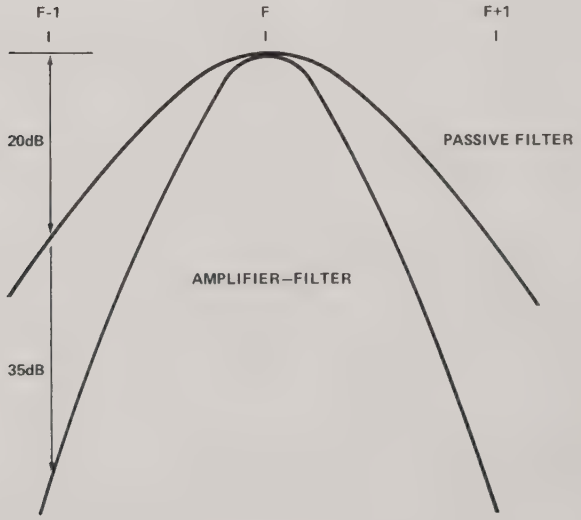

Fig. A-19
Filter Response

Equipment Considerations: (2) Fault Locating Pair

The fault-locating pair is a loaded VF pair to which are bridged as many as 13 passive or 24 powered fault-filters. The cable pair used for this purpose must be in excellent condition, with idle line noise less than 14 dBrnC, in order to provide a useable signal to noise ratio. Both ends of the pair are terminated at the access jacks with 900-Ohm resistors (passive) or 900 Ohms in series with 2μFd capacitors (powered). Powered systems need a means of applying metallic voltage (117 VDC), and reversing the polarity, at the office.

Since the fault-locating test data depends in large measure on the quality of the VF pair, it has become general practice to routinely measure certain fault-line characteristics. For passive systems, a measurement of the loop resistance verifies continuity to the distant termination. The correct resistance value can be calculated using data such as shown in Table A-3. However, the basic reason for making this measurement is simply to ensure physical integrity of the pair. Fault-locating is not possible with a shorted pair and should not be attempted with an open pair. DC continuity does not exist for powered systems because the distant termination includes a blocking capacitor. Measurement of idle line noise is a good indication of the transmission quality and is useful in detecting any degradation of the cable pair. For conventional systems, typical measurements will be in the order of 10 dBrnC with 14 dBrnc considered the upper limit. This, of course, does not apply to T1D installations where typical noise readings will be in the 45 dBrnC range. Test sets with synchronous detectors, such as the 425A-5 DCFA, can work with very noisy lines provided that the noise is really background noise. A high noise reading may indicate severe degradation of the cable pair due to poor balance, crosses, grounds, etc. which will render it useless for fault locating.

TABLE A-3
DC LOOP RESISTANCE
(100°F)

GAUGE	Ω/1000 FT.
19	18
22	35
24	55
26	88

Amplifier-filters are powered by application of a current-limited voltage at the central office. Each amplifier draws approximately 20 microamps, thus 117 VDC is sufficient to place 15 volts at the most distant filter location. Voltage at the fault-locating jack in a CO indicates that a test is being made from the distant office. When voltage is detected at the fault-locating jack, the Fault Locate Test is aborted. The 425A-5 DCFA has the capabililty of powering such lines directly from the test set and always make a voltage check prior to an AUTO fault-locating test.

Equipment Considerations: (3) Special Test Access

Conventional T-carrier systems can be accessed for fault locating at any location with an R IN jack, be it Office Repeater, Span Terminating Bay, or a DSX bay. The AC coupled signal generated by the test set is applied directly to the span line via the passive circuits in the office repeater. Fig. A-20 illustrates various office repeater arrangements.

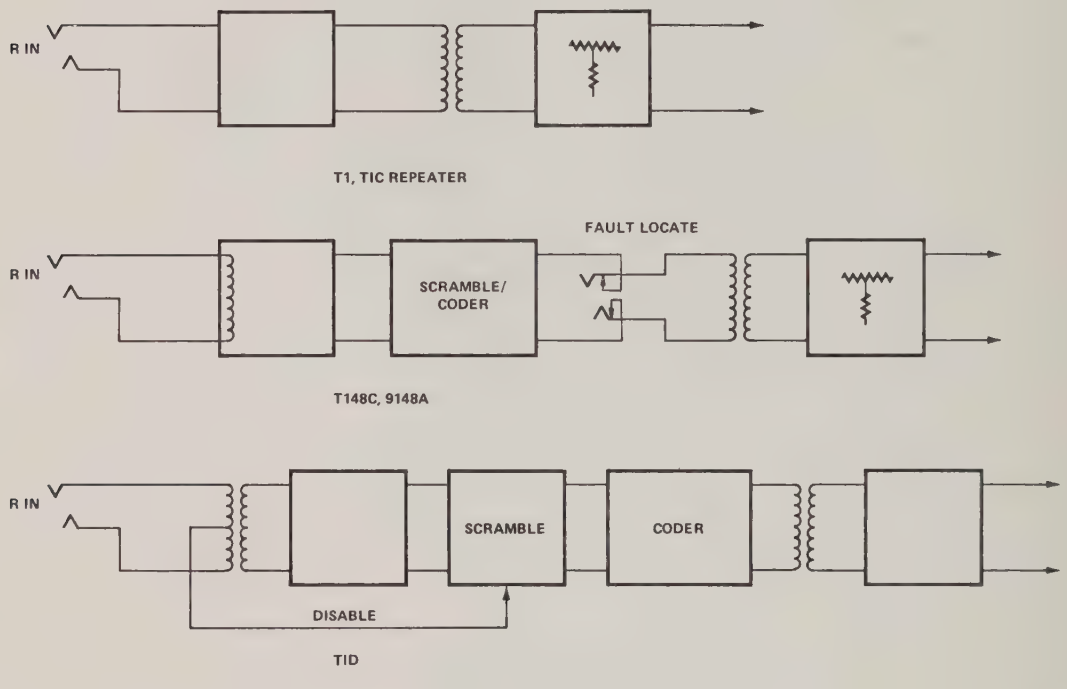

Fig. A-20
Transmit Functions of Office Repeaters

T1D can be accessed in a similar location; however, the test set must have the additional feature of placing +5 VDC on the transmit pair. This voltage disables the scrambler in the office repeater. The T1C signal (consisting of a unique test pattern) is then coded into a duobinary format which contains the audio component necessary for fault locating.

T148C and 9148A also incorporate a scrambler and coder and are equipped with a special test jack for fault-locating which bypasses both. Standard fault-locating trio patterns are used at the actual line bit rates: 2.364 Mb/s for T148C and 3.152 Mb/s for 9148A. In the latter case a double pulse-width pattern is used giving it the appearance of a 100-percent duty cycle T1C signal.

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SIERRA – FL JENNINGS, Division of FL INDUSTRIES, INC., warrants products manufactured by it to be free from defects in material and workmanship and to meet the applicable specifications under normal use and service for a period of 12 months from the date of original shipment by us. Our obligation under this warranty is limited to the repair or replacement of such products which, after having been returned to the factory or a point designated by us, shall be examined and in our sole opinion, found defective and that such defect was not induced by causes external to the product. Alternately, SIERRA may elect to issue credit for any such defective product. All products to be repaired or replaced shall be returned prepaid to the designated place of repair in accordance with authorization and packing and shipping instructions issued by SIERRA. Return shall not be made until such authorization and instructions are issued. Each returned product shall be accompanied by a statement or report fully stating the claimed defects and any other pertinent information concerning the failure.

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